SCIENCE

NEW SERIES. VOLUME LXXIII

JANUARY-JUNE, 1931

NEW YORK
THE SCIENCE PRESS
1931

THE SCIENCE PRESS PRINTING COMPANY
LANCASTER, PA.

CONTENTS AND INDEX

NEW SERIES. VOL. LXXIII—JANUARY TO JUNE, 1931

THE NAMES OF CONTRIBUTORS ARE PRINTED IN SMALL CAPITALS

SCIENCE

VOL. LXXIII — FRIDAY, JANUARY 2, 1931 — No. 1879

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 . — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

PRESENT STATUS OF THEORY AND EXPERIMENT AS TO ATOMIC DISINTEGRATION AND ATOMIC SYNTHESIS[1]

By Dr. ROBERT A. MILLIKAN

CALIFORNIA INSTITUTE OF TECHNOLOGY

MY task to-night is to attempt to trace the history of the development of scientific evidence bearing on the question of the origin and destiny of the physical elements. I shall list ten discoveries or developments all made within the past hundred years which touch in one way or another upon this problem and constitute indications or sign-posts on the road toward an answer. Prior to the middle of the nineteenth century little experimental evidence of any sort had appeared, so that the problem was wholly in the hands of the philosopher and the theologian. Then came, first, the discovery of the equivalence of heat and work and the consequent formulation of the principle of the conservation of energy, probably the most far-reaching physical principle ever developed.

[1] Address of the retiring president of the American Association for the Advancement of Science, Cleveland, December 29, 1930.

Following this and directly dependent upon it came, second, the discovery, or formulation, of the second law of thermodynamics which was first interpreted, and is still interpreted by some, as necessitating the ultimate "heat-death" of the universe and the final extinction of activity of all sorts; for all hot bodies are observed to be radiating away their heat, and this heat, after having been so radiated away into space, apparently can not be reclaimed by man. This is classically and simply stated in the humpty-dumpty rhyme.

As a natural if not a necessary corollary to this was put forward by some, in entire accord with the demands of medieval theology, a *deus ex machinâ* to initially wind up or start off this running-down universe.

Then came, third, the discovery, through studies both in geology and biology, of the facts of evolution

—facts which showed that, so far as the biological field is concerned, the process of creation or upbuilding from lower to higher forms has been continuously going on for millions upon millions of years and is presumably going on now. This tended to call attention away from the *deus ex machinâ,* to identify the creator with his universe, to strengthen the theological doctrine of immanence which represents substantially the philosophic position of Leonardo da Vinci, Galileo, Newton, Francis Bacon, and most of the great minds of history down to Einstein. Neither evolution nor evolutionists have in general been atheistic—Darwin least of all—but their influence has undoubtedly been to raise doubts about the legitimacy of the dogma of the *deus ex machinâ* and of the correlative one of the heat-death. This last dogma rests squarely on the assumption that we infinitesimal mites on a speck of a world know all about how the universe behaves in all its parts, or, more specifically, that the radiation laws which seem to us to hold here can not possibly have any exceptions anywhere, even though that is precisely the sort of sweeping generalization that has led us physicists into error half a dozen times during the past thirty years, and also though we know quite well that conditions prevail outside our planet which we can not here duplicate or even approach. Therefore the heat-death dogma has always been treated with reserve by the most thoughtful of scientists. No more crisp nor more cogent statement of what seems to me to be the correct position of science in this regard has come to my attention than is found in the following recent utterance of Gilbert N. Lewis, namely, "Thermodynamics gives no support to the assumption that the universe is running down." "Gain of entropy always means loss of information and nothing more."

The fourth discovery bearing on our theme was the discovery that the dogma of the immutable elements was definitely wrong. By the year 1900 the element radium had been isolated and the mean lifetime of its atoms found to be about 2,000 years. This meant definitely that the radium atoms that are here now have been formed within about that time, and a year or two later the element helium was definitely observed to be here and now growing out of radium. This raised insistently the question as to whether the creation or at least the formation of all the elements out of something else may not be a continuous process—stupendous change in view-point the discovery of radioactivity brought about, and a wholesome lesson of modesty it taught to the physicist. But a couple of years later, uranium and thorium, the heaviest known elements, were definitely caught in the act of begetting radium and all the allied chain of disintegration products. Since, however, the lifetime of the parent atom, uranium, has now been found to be a billion years or so we have apparently ceased to inquire whence it comes. We are disposed to assume, however, that it is not now being formed on earth. Indeed, we now have good reason to believe that the whole radioactive process is confined to a very few, very heavy elements which are now giving up the energy which was once stored up in them—we know not how—so that radioactivity, though it seemed at first to be pointing away from the heat-death, has not at all, in the end, done so. Indeed, it seems to be merely one mechanism by which stored-up energy is being frittered away into apparently unreclaimable radiant heat—another case of humpty-dumpty.

The fifth significant discovery was the enormous life-time of the earth—partly through radioactivity itself, which assigns at least a billion and a half years—and the still greater lifetimes of the sun and stars—thousands of times longer than the periods through which they could possibly exist as suns if they were simply hot bodies cooling off. This meant that new and heretofore unknown sources of heat energy had to be found to keep the stars pouring out such enormous quantities of radiation for such ages upon ages.

The sixth discovery, and in many ways the most important of all, was the development of evidence for the interconvertibility of mass and energy. This came about in three ways. In 1901 Kaufman showed experimentally that the mass of an electron could be increased by increasing sufficiently its velocity, *i.e.*, energy could be definitely converted into mass. About the same time the pressure of radiation was experimentally established by Nichols and Hull at Dartmouth and Lebedew at Moscow. This meant that radiation possesses the only distinguishing property of mass, the property by which we define it, namely, inertia. The fundamental distinction between radiation and matter thus disappeared. These were direct, experimental discoveries. Next in 1905 Einstein developed the interconvertibility of mass and energy as a necessary consequence of the special theory of relativity. If, then, the mass of the sun could in any way be converted into radiant heat there would be an abundant source of energy to keep the sun going as long as necessary, and all our difficulties about the lifetimes of the sun and stars would have disappeared. But what could be the mechanism of this transformation?

Then came the seventh discovery, which constituted a very clear fingerpost, pointing to the possibility of the existence of an integrating or building up process among the physical elements, as well as in biological forms, in the discovery that the elements are all definitely built up out of hydrogen; for they—the ninety-two different atoms—were all found, beginning about

1913 by the new method of so-called positive ray analysis, to be exact multiples of the weight of hydrogen within very small limits of uncertainty. This fact alone raises very insistently the query as to whether they are not being built up somewhere out of hydrogen now. They certainly were once so put together, and some of them, the radioactive ones, are now actually caught in the act of splitting up. Isn't it highly probable, so would say any observer, that the inverse process is going on somewhere, especially since the process would involve no violation either of the energy principle, or of the second law of thermodynamics; for hydrogen, the element out of which they all must be built, has not a weight exactly one in terms of the other ninety-two, but about one per cent. more than one, so that since mass or weight had been found in the sixth discovery to be expressible in terms of energy, the union of any number of hydrogen atoms into any heavier element meant that one per cent. of the total available potential energy had disappeared and was therefore available for appearance as heat. When, about 1914 or 1915, this fact was fitted by MacMillan, Harkins, and others into the demand made above in the fifth discovery for a new source of energy to keep the sun pouring out heat so copiously for such great lengths of time, it seemed to the whole world of physics that the building up of the heavier elements out of hydrogen under the conditions existing within the sun and stars had been pretty definitely proved to be taking place. This would not provide an escape from the heat-death, but it would enormously postpone it, *i.e.*, until all the hydrogen in the universe had been converted over into the heavier elements.

But by this process the suns could stoke at most but one per cent. of their total mass, assuming they were wholly hydrogen to begin with, into their furnaces, and 99 per cent. of the mass of the universe would remain as cold, dead ash when the fires were all gone out and the heat-death had come. But about 1917 the astronomer began to chafe under the time-limitation thus imposed upon him, and this introduced the eighth consideration bearing upon our theme. He could get a hundred times more time—from now on much more than that because only a small fraction of the matter in the universe is presumably now hydrogen—by assuming that, in the interior of heavy atoms, occasionally a negative electron gets tired of life at the pace it has to be lived in the electron world, and decides to end it all and commit suicide; but, being paired by nature in electron-fate with a positive, he has to arrange a suicide pact with his mate, and so the two jump into each other's arms in the nucleus and the two complementary electron lives are snuffed out at once; but not without the letting loose of a terrific death-yell, for the total mass of the two must be transformed into a powerful ether pulse which by being absorbed in the surrounding matter is supposed to keep up the mad, hot pace in the interiors of the suns. This discovery, or suggestion to account for the huge estimated stellar lifetimes, of the complete annihilation of positive and negative electrons within the nucleus makes it unnecessary to assume, at least for stellar lifetime purposes, the building up of the heavier elements out of hydrogen. Indeed, it seems rather unlikely that both kinds of processes, atom-building and atom-annihilating, are going on together in the same spot under the same conditions, so we must turn to further experimental facts to get more light.

The ninth signpost came into sight in 1927 when Aston made a most precise series of measurements on the relative masses of the atoms which made it possible to subject to a new test the Einstein formula for the relation between mass and energy, namely, $E = mc^2$. This Aston curve is one of the most illuminating finger-pointings we now have. It shows:

1. That Einstein's equation actually stands the quantitative test for radioactive or disintegrating processes right well, and therefore receives new experimental credentials.

2. That the radioactive or disintegrating process with the emission of an alpha ray must be confined to a very few heavy elements, since these are the only ones so situated on the curve that mass can disappear, and hence heat energy appear through such disintegration.

3. That all the most common elements except hydrogen are already in their most stable condition, *i.e.*, their condition of minimum mass so that if we disintegrate them we shall have to do work upon them, rather than get energy out of them.

4. That therefore man's only possible source of energy other than the sun is the upbuilding of the common elements out of hydrogen or helium or else the entire annihilation of positive and negative electrons, and there is no likelihood that either of these processes is a possibility on earth.

5. That if the foregoing upbuilding process is going on anywhere, the least penetrating and the most abundant radiation produced by it, that corresponding to the formation of helium out of hydrogen, ought to be about ten times as energetic as the hardest gamma rays, *i.e.*, it ought to correspond to about twenty-six million electron-volts in place of two and a half million.

6. That other radiations corresponding to the only other abundant elements, namely, oxygen (O, N, C), silicon (Mg, Al, Si), and iron (iron group), should be found about 4 times, 7 times and 14 times as energetic as the "helium rays."

7. That the radiation corresponding to the smallest annihilation process that can take place—the suicide of a positive and negative electron—is 350 times as energetic as the hardest gamma ray, or 35 times as energetic as the "helium ray."

This brings me to the tenth discovery, that of the cosmic rays. These reveal:[2]

1. A radiation the chief component of which, according to our direct comparison, is five times as penetrating as the hardest gamma ray which, with the best theoretical formula we have relating to energy and penetrating power (the Klein-Nishina), means a ray 10 times as energetic as the hardest gamma ray, precisely as per prediction.

2. Spectral bands of cosmic-radiation that are roughly where they should be to be due to the formation of the foregoing abundant elements out of hydrogen, though for reasons to be given presently, no precise quantitative check is to be expected except in the case of helium.

3. No radiation of significant amount anywhere near where it is to be expected from the annihilation hypothesis, thus indicating that at least 95 per cent. of the observed cosmic rays are due to some other less energetic processes.

4. A radiation that is completely independent of the sun, the great hot mass just off our bows, and not appreciably dependent on the Milky Way or the nearest spiral nebula, Andromeda—one that comes in to us practically uniformly from all portions of the celestial dome, and is so invariable with both time and latitude at a given elevation that the observed small fluctuations at a given station reflect with much fidelity merely the changes in the thickness of the absorbing air blanket through which the rays have had to pass to get to the observer.

This last property is the most amazing and the most significant property exhibited by the cosmic rays, and before the drawing of final conclusions its significance will be discussed. For it means that at the time these rays enter the earth's atmosphere, they are practically pure ether waves or photons. If they were high speed electrons or even had been appreciably transformed by Compton encounters in passing through matter into such high speed electrons or beta rays, these electrons would of necessity spiral about the lines of force of the earth's magnetic field and thus enter the earth more abundantly near the earth's magnetic poles than in lower latitudes. This is precisely what the experiments made during the last summer at Churchill, Manitoba (lat. 59), within 730 miles of the north magnetic pole, showed to be not true, the mean intensity of the rays there being not measurably different from that at Pasadena in latitude 34.

Nor is the conclusion that the cosmic rays enter the earth's atmosphere as a practically pure photon beam dependent alone upon these measurements of last summer. It follows also from the high altitude sounding balloon experiments of Millikan and Bowen in April, 1922, taken in connection with the lower balloon flights of Hess and Kolhörster in 1911–14. For in going to an altitude of 15.5 kilometers we got but one fourth the total discharge of our electroscope which we computed we should have obtained from the extrapolation of our predecessors' curves. This shows that somewhere in the atmosphere below a height of 15.5 kilometers the intensity of the ionization within a closed vessel exposed to the rays goes through a maximum and then decreases, quite rapidly, too, in going to greater heights. We have just taken very accurate observations up to the elevation of the top of Pike's Peak (4.3 kilometers) and found that within this range the rate of increase with altitude is quite as large as that found in the Hess and Kolhörster balloon flights, so that there can be no uncertainty at all about the existence of this maximum. Such a maximum, however, means that the rays, before entering the atmosphere, have not passed through enough matter to begin to get into equilibrium with their secondaries—beta rays and photons of reduced frequency—in other words, that *they have not come through an appreciable amount of matter in getting from their place of origin to the earth.*

This checks with the lack of effect of the earth's magnetic field on the intensity of the rays and the two phenomena, of quite unrelated kinds and brought to light years apart, when taken together, prove most conclusively, I think, that the cosmic rays can not originate even in the outer atmospheres of the stars, though these are full of hydrogen and helium in a high temperature state, but that they must originate rather in those portions of the universe from which they can come to the earth without traversing matter in quantity that is appreciable even as compared with the thickness of the earth's atmosphere—in other words, *that they must originate in the intensely cold regions in the depths of interstellar space.*

Further, the more penetrating the beta rays produced by Compton encounters the greater the thickness of matter that must be traversed before the beam of pure photons which enters the atmosphere gets into equilibrium with its secondaries, and until such equilibrium is reached, the apparent absorption coefficient must be less than the coefficient computed with the aid of the Klein-Nishina formula from the energy released in the process from which the radiation arises.

[2] See articles by Millikan and Millikan and Cameron, *Phys. Rev.*, December 1, 1930, and February or March, 1931.

Now the Bothe-Kolhörster experiments of about a year ago show that when the energies of the incident photons are sufficiently high the beta rays released by Compton encounters do indeed become abnormally penetrating so that it is to be expected that, for the cosmic rays produced by the formation of the heavier of the common elements like silicon and iron out of hydrogen, the observed absorption coefficients will be somewhat smaller than those computed from the energy available for their formation. This is precisely the behavior which our cosmic ray depth-ionization curve actually reveals. At the highest altitudes at which we have recently observed (14,000 feet) the helium rays have reached equilibrium with their secondaries, and the observed and computed coefficients agree as they should. For the oxygen rays the observed coefficient is a little lower than the computed value—about 17 per cent. lower—for the silicon rays still lower—about 30 per cent.—and for the iron rays considerably lower still—about 60 per cent.—all in beautiful qualitative agreement with the theoretical demands as outlined.

The foregoing results seem to point with much definiteness to the following conclusions:

1. That the cosmic rays have their origin, not in the stars, but rather in interstellar space.

2. That they are due to the building in the depths of space of the commoner heavy elements out of hydrogen which the spectroscopy of the heavens shows to be widely distributed through space. That helium and the common elements oxygen, nitrogen, carbon and even sulphur are also found between the stars is proved by Bowen's beautiful recent discovery that the "nebulium lines" arise from these very elements.

3. That these atom-building processes can not take place under the conditions of temperature and pressure existing in the sun and stars, the heats of these bodies having to be maintained presumably by the atom-annihilating process postulated by Jeans and Eddington as taking place there.

4. All this says nothing at all about the second law of thermodynamics or the "Wärme-Tod," but it does contain a bare suggestion that if atom formation out of hydrogen is taking place all through space as it seems to be doing, it may be that the hydrogen is somehow being replenished there too from the only form of energy that we know to be all the time leaking out from the stars to interstellar space, namely, radiant energy. This has been speculatively suggested many times before in order to allow the creator to be continually on his job. Here is perhaps a little bit of *experimental* finger-pointing in that direction. But it is not at all proved nor even perhaps necessarily suggested. If Sir James Jeans prefers to hold one view and I another on this question no one can say us nay. The one thing of which you may all be quite sure is that neither of us *knows* anything about it. But for the continuous building up of the common elements out of hydrogen in the depths of interstellar space the cosmic rays furnish excellent experimental evidence. I am not unaware of the difficulties of finding an altogether satisfactory kinetic picture of how these events take place, but acceptable and demonstrable facts do not, in this twentieth century, seem to be disposed to wait on suitable mechanical pictures. Indeed, has not modern physics thrown the purely mechanistic view of the universe root and branch out of its house?

SCIENTIFIC EVENTS

ANNUAL REPORT OF THE DIRECTOR OF THE U. S. GEOLOGICAL SURVEY

THE annual report recently issued by Dr. George Otis Smith, director of the U. S. Geological Survey, states that the fifty-first year of the U. S. Geological Survey has been the largest and broadest of its history in expenditure and in activities. The sum of more than four million dollars was expended in highly specialized service, yielding results much varied in type but alike in contributing to the industrial development of the country.

The Geological Survey has been most intimately connected with western development, and that development is far from completed. The strictly exploratory work of the survey is now in large measure confined to Alaska, but the more intensive phases of agricultural, industrial and mining development have barely begun in much of the western territory.

Some measure of the increasing activity of the survey is afforded in the statistical record of its fifty-first year. As compared with the previous year, the fiscal year 1930 shows increases of nearly 10 per cent. in total expenditures, nearly 20 per cent. in new maps issued, and nearly 30 per cent. in number of book publications. The personnel, of which more than 80 per cent. is professional in type, was larger than even in the years when the Bureau of Mines was a branch of the organization. Indeed, the appropriations this year exceeded by 50 per cent. those for 1910, the last year before the Bureau of Mines was separated from the Geological Survey, and the total expenditures in 1930, including cooperative funds, were more than

double those in 1910. This 20-year period since the separation of these two services especially directed to the promotion of the mining industry has been one of notable growth for both; yet because of the postwar economies their growth has not approached that of the industry they serve.

The discovery of geology by industry in recent years has placed the small corps of government scientists under new and larger obligations. The army of geologists and engineers in commercial work necessarily looks to the federal service for the collection of geologic facts and the working out of new generalizations and principles. High-pressure industrial development throughout the country has involved an increasing demand for raw materials, with a corresponding larger need for basic engineering information. The demand for intensive study of ore possibilities is most active in the same mining states—Colorado and Nevada—where the first mining work of the Geological Survey was done, the production of the epoch-making monographs on Leadville, Eureka and the Comstock, which had as their purpose to meet the anxious desires "of miners as well as of students of geology and economy."

Another phase of governmental activity hardly foreseen in the beginning is the degree to which the public domain is administered on a scientific basis. In the twenty years beginning in 1907 approximately a million dollars was spent for geologic work in areas in which the federal government owns coal lands. Upon this investment of appraising its property the government is now collecting between $400,000 and $500,000 a year in royalties from coal mined from government leases. The oil and gas leases have been still more productive, although the chief contribution of this service to the public interest has been the conservation of the natural resources belonging to the people. The enforcement of the best economic practices by the federal engineers is their contribution to the conservation of life and health, both the zinc and the coal mines under federal supervision showing better accident records than other mines in the same states.

THE NATIONAL PARK SERVICE

THE cooperation of the National Park Service in affording relief to local unemployment during the past season is outlined in detail by Horace M. Albright, director of the National Park Service.

Upon telegraphic receipt last spring from the Washington office of the signing of the 1930 appropriation act of the Interior Department, throughout the national park system action was immediately taken to get construction under way and to purchase equipment. The headquarters office kept in close touch with the field, making adjustments and transfers of funds where necessary to enable the park superintendents to carry on to the best advantage.

In addition to beginning construction and improvement work early in the season, these activities were carried on all summer under full steam and as late into the fall as weather conditions permit. Yosemite National Park, California, reports that it already has continued operations five weeks longer than last year, and proposes to continue until heavy snowfall shuts up the last activities. A few days ago it was reported that despite the heavy snows which necessitated shutdowns of work in the mountainous back country, 358 people were still on the pay roll. This is in addition to the highway construction being carried on under contract.

One of the highway jobs, that of building a tunnel through solid rock, will continue all winter, and the contractor in charge has agreed to take many men from the park forces as other work is suspended through climatic necessity.

In Carlsbad Caverns National Park work will continue all winter on the construction of an elevator shaft, 750 feet deep, and the installation of elevator equipment. Contracts will be awarded within a few days to enable work to commence at once.

At Hot Springs National Park award has just been made covering the construction of a complete hot-water system collecting all hot water from the springs, and also for the construction of concrete reservoirs, pumping station, pipe lines, etc. Much labor will be employed directly by the government.

Contracts will soon be let for the purchase of the pumping and electrical equipment. This project will cost approximately $140,000 and will materially improve the unemployment situation in the Hot Springs region during the period of greatest winter stress.

Work will also be continued during the winter in Wind Cave National Park, where a lighting system will be installed, and in the Mesa Verde, where a deep water well—probably 3,600 feet or more deep—will be drilled.

In Grand Canyon National Park, work will be in progress all winter on the reconstruction of the Bright Angel Trail. This trail is one of the long-remembered features of Grand Canyon by all those who either hike or ride mule-back into the depths of the canyon. It passes along ledges and through clefts in the solid rock walls. The new trail now being constructed will still be just as spectacular as the old one, but of sufficient width and ease of grade to afford perfect safety.

THE NIAGARA FRONTIER RESEARCH COUNCIL

THE Niagara Frontier Research Council has completed its organization to include investigators repre-

senting each branch of pure and applied science in which research is being carried on in the Niagara area. Buffalo and Niagara Falls are the central communities in the area which includes Erie and Niagara Counties of western New York.

The objects of the council are to promote scientific research and coordinate so far as possible the research work done in the area in order that duplication may be prevented and closer relations established between the individuals engaged. Buffalo and Niagara Falls by virtue of their varied industries are said to be particularly fitted to benefit by a council of this sort.

The members and the fields of research they represent include:

Dr. Charles J. Fish, *President*, Buffalo Museum of Science, zoology.

Cedric A. Vincent-Daviss, *Vice-president*, Roessler & Hasslacher, Niagara Falls, N. Y., chemistry.

William N. Kessel, *Secretary*, Buffalo Chamber of Commerce, business.

Christopher H. Bierbaum, Lumen Bearing Company,

Professor John A. Curtin, D'Youville College, meteorol-

engineering.

ogy and astronomy.

George A. Davis, Buffalo, astronomy.

Professor John P. Delaney, Canisius College, seismology.

Robert W. Elmes, Buffalo Chamber of Commerce, business.

Charles Ward Hall, Hall Aluminum Aircraft Corporation, aeronautics.

Dr. L. Grant Rector, University of Buffalo, physics.

Dr. Frances M. Hollingshead, Buffalo Foundation, social science.

Dr. Frans Visser't Hooft, Lucidol Corporation, chemistry.

Dr. Edward W. Koch, University of Buffalo, medicine.

J. Allen Johnson, Buffalo, Niagara and Eastern Power Corporation, engineering.

James A. Johnson, Buffalo, radio.

Stephen T. Lockwood, Buffalo, engineering.

Dr. R. H. Pegrum, University of Buffalo, geology.

R. R. Ridgway, Niagara Falls, electrochemistry.

Wilbert H. Spencer, University of Buffalo, botany.

Dr. A. A. Thibaudeau, State Institute for the Study of Malignant Diseases, physiology.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

AT its meeting in December the National Research Council's committee on grants-in-aid made eighteen grants for the support of research, as follows:

R. C. Gibbs, professor of physics, Cornell University, the measurement and interpretation of the structure of lines in the atomic spectra of nitrogen; George R. Harrison, professor of physics, Massachusetts Institute of Technology, the determination of transition probabilities in multiple ionized atoms; Mark H. Liddell, professor of English, Purdue University, physical characteristics of speech sounds.

John B. Whitehead, professor of electrical engineering, the Johns Hopkins University, studies upon insulating oils.

Warren O. Thompson, assistant professor of geology, University of Colorado, stratification of unconsolidated deposits.

Sydney W. Britton, professor of physiology, University of Virginia Medical School, the isolation and evaluation of the function of the cortico-adrenal hormone; Israel L. Chaikoff, instructor in physiology, University of California Medical School, the relationship of high fat diets to arteriosclerotic changes in depancreatized dogs: E. A. Doisy, professor of biochemistry, St. Louis University School of Medicine, the female sex hormone; James Ewing, professor of pathology, Cornell University Medical College, the possible tuberculous nature of Hodgkin's granuloma; E. B. Krumbhaar, professor of pathology, University of Pennsylvania School of Medicine, the mechanism of opsonin and bacteriotropin action; Mildred Trotter, associate professor of anatomy, Washington University, the weight of hair in relation to its form, size and color.

Bennet M. Allen, professor of zoology, University of California at Los Angeles, the influence of the thyroid gland and hypophysis upon growth and development; Lee R. Dice, assistant professor of zoology, University of Michigan, variability in subspecies of *Peromyscus maniculatus;* Francis W. Pennell, curator of plants, Academy of Natural Sciences of Philadelphia, Scrophulariaceae of the northwestern part of the United States; Charles H. Philpott, professor of zoology, Harris Teachers College, the effects of snake venoms on certain protozoa.

Melville J. Herskovits, assistant professor of anthropology, Northwestern University, Africanisms in the American Negro; Melville Jacobs, instructor in anthropology, University of Washington, the preservation of extinct or nearly extinct Indian tribal songs of northwestern Oregon.

VERNON KELLOGG,
Permanent Secretary, National Research Council

OFFICERS OF THE AMERICAN CHEMICAL SOCIETY

PROFESSOR MOSES GOMBERG, of the University of Michigan, became president of the American Chemical Society on January 1. Professor Gomberg will serve during 1931, succeeding Dean William McPherson, of the Ohio State University.

Dr. L. V. Redman, vice-president and director of research of the Bakelite Corporation, Bloomfield, New Jersey, has been elected president of the society in 1932. The other nominees were Professor Joel H. Hildebrand, of the University of California; Professor Samuel C. Lind, of the University of Minne-

sota, and Professor Hugh S. Taylor, of Princeton University.

In accordance with a recent change in its constitution, the society now elects each year a president and a president-elect, who serve in successive years. The society's membership of 18,000 in all parts of the country participate in the annual election.

Dr. W. D. Bigelow, director of research of the National Canners Association, Washington, D. C., and Walter A. Schmidt, president of the Western Precipitation Company, Los Angeles, were elected district directors: *Directors-at-large* were named as follows: Thomas Midgley, Worthington, Ohio, noted for his discovery in the laboratories of the General Motors Corporation at Dayton of ethyl gasoline and of a new non-toxic and non-inflammable refrigerant; George P. Adamson, of Searsport, Maine, long identified with chemical industries, including the Baker and Adamson Company, the General Chemical Company and the Allied Chemical and Dye Corporation; Milton C. Whitaker, New York, president of the Catalytic Process Corporation, formerly professor in Columbia University and vice-president of the U. S. Industrial Alcohol Company; R. E. Wilson, Chicago, assistant to the vice-president and in charge of development and patent department of the Standard Oil Company of Indiana.

Councilors-at-large are: F. C. Frary, director of research, Aluminum Company of America, New Kensington, Pa.; Professor H. N. Holmes, Oberlin College; Dr. E. H. Volwiler, director and chief chemist of the Abbott Laboratories, Chicago; R. E. Wilson.

The reserve fund of the society at the beginning of 1930 was just over $300,000 and its trust funds amounted to nearly $184,000. Through the will of W. H. Nichols, $50,000 will be added to the funds of the society. The expenditures of the year were estimated at $557,560.

SCIENTIFIC NOTES AND NEWS

Mr. W. C. Mendenhall, chief geologist of the U. S. Geological Survey, has been made acting director of the survey to succeed Dr. George Otis Smith, who was recently appointed chairman of the reorganized Federal Power Commission.

Professor Albert Einstein has accepted an invitation to become Cecil Rhodes Memorial Lecturer at the University of Oxford, where he will reside during the summer term.

Dr. William H. Welch, of the Johns Hopkins University, and Dr. John A. Hartwell, of Cornell University Medical College, were guests of honor at a dinner in New York City on December 6 to celebrate the seventieth anniversary of the German Medical Association of New York.

Dr. Walter B. Cannon, George Higginson professor of physiology at the Harvard Medical School, who recently became a foreign honorary fellow of the Royal Society of Edinburgh, received on November 15 the degree of doctor *honoris causa* from the University of Liége. On November 22 the same honorary degree was conferred on him by the University of Strasbourg.

Dr. Frederick E. Breithut, president of the American Institute of Chemists, Inc., has been elected, *ex officio*, an honorary member of the Chemical, Metallurgical and Mining Societies of South Africa.

The gold medal of the Radiological Society of North America has been awarded, for achievement in the science of radiology in its application to diseases of women, to Dr. Henry Schmitz, professor of gynecology and head of the department at the Loyola University School of Medicine, Chicago.

The Mackenzie Davidson Medal of the British Institute of Radiology was awarded to Professor G. P. Thomson, of the Imperial College of Science and Technology, and the Silvanus Thompson Medal to Dr. A. E. Barclay, lecturer in medical radiology and electrology in the University of Cambridge, on the occasion of the recent annual congress and exhibition of the institute. Dr. Thomson and Dr. Barclay delivered memorial lectures.

The Gedge Prize of the University of Cambridge for original observations in physiology has been awarded to Mr. H. Barcroft, B.A., of King's College, who gained first class honors in the Natural Sciences Tripos, Part II, in 1927.

Lord Eustace Percy was elected president of the Royal Institution, London, on December 1, in succession to the late Duke of Northumberland. Lord Eustace was president of the Board of Education in 1924–29 and this year is president of Section L (Educational Science) of the British Association.

M. le Général Bourgeois has been elected vice-president of the Paris Academy of Sciences for the year 1931.

Honorary doctorates have been conferred by the University of Liége on M. Emile Picard, permanent secretary of the Paris Academy of Sciences, on M. Jean Perrin, professor of physical chemistry, and M. Louis Lapicque, professor of physiology, of the Col-

lège de France, and on Dr. A. Calmette, of the Pasteur Institute, Paris.

DR. FRIEDRICH STOTZ, of Heilbronn, the inventor of synthetic adrenaline, who recently celebrated his seventieth birthday, has been named doctor *honoris causa* by the medical faculty of the University of Marburg.

THE General Board of the University of Cambridge has recommended that a professorship of geography be created as from January 1, 1931, and that the present reader in geography, Mr. F. Debenham, be the first holder of the chair. A professorship of experimental psychology will also be created, the present reader in experimental psychology, Mr. F. C. Bartlett, to be the first incumbent. The stipend attached to these professorships is £1,200.

THE chair of zoology in the University of Capetown, vacated by Mr. L. Hogben on his appointment as professor of social biology in the University of London, has been filled by the election of Dr. T. A. Stephenson. Dr. Stephenson has been for some years a lecturer in the department of zoology at University College, London, and was a member of the recent research expedition to the Great Barrier Reef.

DR. WILHELM SCHMIDT has been appointed to succeed the late Professor F. M. Exner as professor of geophysics at the University of Vienna and director of the Institute of Meteorology and Geodynamics.

DR. CARLETON R. BALL, until recently principal agronomist in charge of the office of cereal crops and diseases of the Bureau of Plant Industry of the U. S. Department of Agriculture, has been appointed research associate in the University of California, effective on January 1. He will take up a survey of the relationships of the federal, state and local county or city governments in the numerous and varied agricultural activities in California. This survey will be conducted by the Bureau of Public Administration of the Department of Political Science, with funds provided by the Rockefeller Foundation. It is one, and the first, of a series designed to cover these relationships in all human activities in the state.

DR. NEIL E. STEVENS, of the U. S. Department of Agriculture, has been transferred from the office of horticultural crops and diseases to the office of mycology and disease survey of the Bureau of Plant Industry. In his new assignment Dr. Stevens will conduct research on epidemiology of plant diseases, and will also direct the plant disease survey, formerly under the supervision of Dr. R. J. Haskell. The survey, in cooperation with the state agricultural college experiment stations, extension services and other agencies, will continue to collect, summarize and interpret data on the occurrence and distribution of plant diseases for use by workers in the department and state experiment stations.

VICTOR O. HOMERBERG, associate professor of physical metallurgy at the Massachusetts Institute of Technology, has been appointed technical director of the Nitralloy Corporation, New York City.

MR. P. H. GRIMSHAW has been appointed keeper of the Natural History Department in the Royal Scottish Museum in succession to Dr. J. Ritchie, who was recently appointed Regius professor of natural history in the University of Aberdeen.

PRESIDENT KARL T. COMPTON, of Massachusetts Institute of Technology, addressed the Western Society of Engineers in Chicago on December 1 on "Electron Emission from Metals." He also addressed the alumni of the College of the City of New York at their annual dinner at the Hotel Biltmore on Saturday, November 15, on "What can be Expected of Scientific Research?" On Friday, October 24, he gave the dedication address for the new physical laboratory at the University of Richmond on "Civilization and the Physical Laboratory."

DR. JAMES EWING, professor of pathology at Cornell University Medical College, New York, will give the tenth annual Beaumont lectures on January 26 and 27, in Detroit, under the auspices of the Wayne County Medical Society. The lectures will treat the causation, diagnosis and treatment of cancer.

DR. WALTER B. CANNON addressed the Harvard Medical Society, on December 9, on "The Emotional Increase of Heart Rate."

DR. J. BRONTË GATENBY, of Trinity College, Dublin, lectured at the University of Michigan, under the auspices of the department of zoology, on December 4 and 5, on "X-rays, Radium and Phosphorus, and the Cell," "Review of Various Theories of the Structure of the Cell," "Cytoplasmic Inclusions in the Germ-cell Cycle" and "Lines for Further Research."

PROFESSOR ARTHUR A. ALLEN, of Cornell University, lectured on December 11 and 12 at the University of Michigan under the auspices of the department of zoology on the following subjects: "Courtship and Home Life of Birds," "The Ruffed-Grouse—a Cooperative Investigation" and "The University and the Conservation of Wild Life."

PROFESSOR DOUGLAS JOHNSON, of Columbia University, addressed the Geographic Society of Chicago on December 9 on "The Unresting Sea." The previous day he discussed "Shore Benches of the Pacific Coasts" at a meeting of graduate students and faculty members of the Department of Geology and Geography at Northwestern University, and on December 10 lec-

tured at Wooster College, Ohio, on "Interpretations of Coastal Scenery."

THE International Exhibition of Hygiene at Dresden, which was closed on October 13, will be reopened next year from May 15 to September 30.

Nature reports that an international celebration and exhibition to mark the three hundredth anniversary of the first recognized use of cinchona by Europeans was held at the Wellcome Historical Medical Museum, London, on December 8 and 10. Addresses were given by the Marquis de Merry del Val, Ambassador for Spain; Archbishop Goodier, formerly Archbishop of Bombay; Sir David Prain, formerly director of the Royal Botanic Gardens, Kew, and Sir Humphry Rolleston, Regius professor of physic in the University of Cambridge. There was an extensive collection of exhibits arranged to illustrate the history of cinchona.

WE learn from the *Journal* of the American Medical Association that a microscope thought to be nearly 200 years old has been presented to the New York Academy of Medicine by Dr. Warren Coleman. The case bears a brass plate on which is engraved: "This Microscope brought from Holland by Jan Evertson Keteltas in the year 1649 is given by his Descendant Henry Keteltas Aug 12th 1895 to Doctor Warren Coleman as a pleasant remembrance." According to a plate inside the case, the instrument was made by Benjamin Cole, who is known to have entered business in London in 1751. Authorities believe, therefore, that the microscope given to Dr. Coleman was not the one originally brought to this country in 1649, but one that replaced it about 100 years later.

THE Royal Institution, London, has received an intimation from the Pilgrim Trust that the trustees have allocated the sum of £16,000 to meet the deficiency on the fund for the reconstruction of the institution. The trustees state that, in making this grant, they had regard to the distinguished scientific services rendered to the whole community by the Royal Institution for over a century, and to the approaching Faraday celebrations. They were also not unmindful that the founder of the Royal Institution, Count Rumford, was of American origin.

FOR the purpose of providing adequate laboratory facilities for the departments of medicine, surgery, pathology, bacteriology and allied subjects of the medical curriculum, the Rockefeller Foundation of New York has contributed £100,000 to the University of Sydney. Since the establishment of full-time chairs in medicine, surgery and bacteriology, made possible by the generosity of Mr. George Bosch, of Sydney, the medical school of the university has been brought within the scope of the activities of the Rockefeller Foundation. This gift to the university was the outcome of the visit of Mr. Bosch and Professor Stump to America last January, when they explained in person the plans which the university had in view.

THE committee on pharmacology and therapeutics of the Council on Dental Therapeutics of the American Dental Association announces that it has at its disposal a small fund to aid investigations which may be of therapeutic interest in the field of dentistry. The grants will be limited to the purchase of materials or special equipment. Applications should be addressed to the secretary, Dr. S. M. Gordon, 58 East Washington Street, Chicago, Illinois.

THE *ex-officio* Montana State Board of Entomology, set up in 1913, has devoted itself to the study of Rocky Mountain spotted fever, the tick which carries it and, in recent years, to tick parasites. It now desires to turn over the entire research program, as well as the new laboratory erected by the State of Montana, to the National Institute of Health, created by the Congress in May, 1930. In this plan the Board of Entomology has the support of the American Public Health Association, many state and city health officers and many interested individuals in both the eastern and western United States. The United States Public Health Service has been engaged in the study of this human disease in Montana for many years and has a staff of workers at the board's laboratory at Hamilton, Montana. The Public Health Service has discovered an effective spotted-fever vaccine and has been making it at the Montana laboratory and supplying it to the some thirteen states which need it. The problem of the control of Rocky Mountain spotted fever is much more than a local one and it is believed that it will be more appropriate for the National Institute of Health to have entire charge, thereby relieving the State of Montana, and at the same time making it possible to enlarge the studies and extend them into the other affected states.

AT the anniversary meeting of the Royal Society, Sir Ernest Rutherford, the retiring president, announced that by an alteration of the existing statute regulating the election of fifteen fellows annually, and enacted in 1847, the number to be recommended for election in future would be seventeen.

THE Royal Anthropological Institute, according to *Nature*, has created a class of associates with the object of bringing its facilities for study and research within the reach of the younger workers in anthropological subjects. Associates must be less than twenty-six years of age, they will pay an annual subscription of one guinea only, will receive the institute's monthly publication (*Man*), and will have access to the library and ordinary meetings.

THE East Malling Horticultural Research Station, Kent, England, has arranged for the investigations of six fruit experts from the Dominions to work at the station. The plan is financed by the Empire Marketing Board, and aims at helping fruit production in the Empire by enabling investigators who are taking up fruit research in the Dominions to see at first hand what is being done by their fellow-workers in the home country. Post-graduate workers will be invited to carry out individual research at the station for a period of two years. The East Malling Research Station is the present headquarters of the Imperial Bureau of Fruit Production, one of the eight agricultural research bureaus recently set up to coordinate fruit research throughout the Empire. Mr. R. G. Hatton, director of the station, is at present on an Empire tour, under the auspices of the Empire Marketing Board, during which he will visit Canada, Australia, New Zealand and Ceylon. The research station at East Malling has recently been enlarged as an Empire center for the study of all aspects of fruit culture under temperate conditions. The largest experimental cold store in the world, known as the Ditton Laboratory, has been opened for research into the cold storage of fruit. It contains a "model ship's hold," capable of taking 120 tons of apples, in which conditions on board ship can be almost exactly imitated.

Industrial and Engineering Chemistry reports that the Chung Hua Chemical Research Laboratory was founded in Shanghai in 1929 by the joint effort of the Tienchu Manufacturing Company and P. N. Woo, superintendent and chemical engineer of that concern. The motive for founding this laboratory was to stimulate industrial chemical research and to arouse interest among manufacturers in China to establish industrial fellowships similar to those of the Mellon Institute. At present it has two such fellowships. The laboratory employs three chemists with its annual fund mostly contributed from the founders. The administration is vested in the hands of a board of directors, consisting of nine members, one of whom is the director of the laboratory. Besides cooperating with other parties in solving their chemical and technical problems, the junior staff is doing general analytical work for business people. As a side issue, the laboratory is also acting as purchasing agent for those who wish to buy foreign scientific apparatus and factory equipment. In any case, only a nominal fee is charged and that is utilized solely for the expansion of the laboratory.

DISCUSSION

OUR FAUNA

GATES[1] has recently pointed out how little we know what earthworms may be found in that part of America whose fauna has been studied for the longest period of time, not to mention our lack of knowledge concerning their distribution, life history and ecology.

What is true of earthworms, a group of particular economic importance, is even more true of the moss mites (Oribatoidea). For instance, in one subfamily but one species had been recorded from New York and New England until the writer in 1929 added ten, chiefly from Connecticut. Among the Phthiracaridae but one species had been recorded from New England when in 1930 the same worker added sixteen, of which ten came from one locality. What is true of the above subfamilies, chosen at random, is true of others.

Not only are the species unknown, but in all papers that have come to my attention which claim to analyze or summarize the fauna of a given tract or area the Oribatoidea are ignored, or rarely a generic name appears. Even such "monographs" as Weese's[2] and Blake's,[3] which include turf and soil population, entirely ignore this group. Yet every cubic foot of forest floor contains dozens if not a hundred to two hundred, while no cubic foot of meadowland is without them if present random collections are indicative of general conditions. Furthermore, these animals are visible to a sharp eye.

What is true of the moss mites is equally true of other groups of Acarina, of Tardigrades and of other inconspicuous groups.

Undoubtedly, to know one's fauna is a fundamental necessity and is the only reason for the existence of a national Biological Survey. Were our fauna better known we would not have anatomists, histologists and experimental biologists working on material which represents two or three species (as has been done on Amoeba,[4] Paramecium[5] and even some fishes, or on wrongly identified material as in the case of Hydra,[6] numerous parasites and arthropods).

When one reviews such admirable, comprehensive faunal works as the "Tierwelt Mitteleuropas," "Faune de France," etc., one realizes how far behind is New England, even New York State (not to mention the rest of our extensive domain), in knowing the animal life available for advanced studies. Why should the Biological Survey confine its interest to flowering plants, mammals, birds and a little of other conspicuous forms while all the rest of the plant and

[1] SCIENCE, 60: 266–267, September 13, 1929.
[2] Illinois Biol. Monog., 9: no. 4, 1924.
[3] *Ibid.*, 10: no. 4, 1926.

[4] Schaeffer, Carnegie Inst. Pub. no. 345, p. 3.
[5] Wenrich, *Trans. Am. Micr. Soc.*, 47: 275.
[6] Hyman, *Trans. Am. Micr. Soc.*, 48: 242, ¶ 2.

animal kingdoms are, for the most part, neglected? True, the Bureau of Entomology studies insects but only the few of economic importance. Likewise the National Museum and other museums study some other groups, but what is needed is comprehensive and complete floral and faunal studies similar to those undertaken by the Biological Survey on mammals for all our animals and plants. The work done on mammals is admirable and highly commendable, but why exclude most of the other groups? We have only begun our biological survey.

Again, why do our New England museums and universities spend thousands of dollars to explore remote regions when they have not yet studied the fauna of their own country, not to mention state? There is one definite answer: because their staff is made up largely of mammalogists, ornithologists, herpetologists and other megascopologists who have exhausted the new species of their own countries and must find them elsewhere. The detailed distribution and life history of some of our New England mammals is still to be worked out, but new species from Brazil or the Congo make more appeal to the taxonomist. Could we not have more *bio*logists in our museums, or microfaunologists?

A water-bear enlarged to the size of a polar bear would attract a far bigger sightseeing crowd than would a floe-full of the latter. Why not give our industrial brothers the benefit of our experiences with the microscope and broaden their background to a limitless extent? A beginning has been tried with marked success at the American Museum; why not elsewhere and more extensively? Would not a two-foot model of a specimen of each family of invertebrates raise the hair on the neck of every city dweller? Would anything be more comical and instructive than a row of bee faces enlarged to a diameter of three or six inches? Should not our museums cut down their present large staff of experts on vertebrates in order to take on workers on less conspicuous animals? Would the state and local authorities welcome large models of bizarre invertebrates to take the place of cases of vertebrate skins? Each worker on such models would have to study his local fauna so that the biological survey of the neglected would develop from different centers, but its coordination should center at Washington.

Arthur Paul Jacot

Shantung Christian University,
China

DINOSAUR EGG SHELL FRAGMENTS FROM MONTANA

Following the announcement on October 13 that small fragments of shell, probably of dinosaur eggs, were found last summer near Red Lodge, Montana, by the Scott Fund Expedition, of Princeton University, the press has incubated the scraps so assiduously in the desire for "bigger and better" eggs that the resultant newspaper hatch reveals a number of amazing and monstrous hybrids. A foreign publication reports that the eggs found were eight feet long. In America an editorial discloses the delight of collectors in finding a whole nest of complete eggs after a gruelling search, and draws a moral therefrom. Another correspondent intimates that, since the Montana shell scraps are nearly black, the parent dinosaurs were black.

The reappearance of the postulation that dinosaurs had extinction forced upon them by the egg-eating habit of some of the contemporary mammals is one of the examples of atavism among the recent brood of mystic reports.

Due to these and other equally distorted, but popular, tales about the Red Lodge shell bits, several appeals for accurate information have been received. In an attempt to forestall any further exploitation of the discovery, or any even greater exaggeration of its importance, it seems desirable to make a statement concerning the circumstances of the find and the limited material collected.

Mr. E. J. Moles, Jr., a senior in the Princeton department of geology, and the writer spent the latter part of last summer in the vicinity of Red Lodge, at the invitation of Dr. J. C. F. Siegfriedt, in a search for vertebrate fossils which might aid in determining the stratigraphic elements and boundaries of the local Fort Union formation.

An attempt to locate the highly controverted and critical division between the Fort Union and the underlying Lance formation was undertaken in part because of the practical commercial value of the information to local oil and coal operators. This work was an extension of that begun in 1928 and 1929 by Scott Fund expeditions in the Bighorn Basin about twenty miles to the south, near Powell, Wyoming, where the boundary in question was established by the fortunate discovery, in the base of a massive persistent sandstone, of a Puerco, or Lower Fort Union, fauna only twenty feet above dinosaur remains in the Lance shale.

Geological essays sometimes become warm at the mention of the Lance-Fort Union contact because of the many interpretations which various reasoners have given the evidences that the Lance should be regarded as either Upper Mesozoic or Lower Cenozoic in age. The Lance strata east of Red Lodge are poorly exposed in most of the area due to the vegetation and soil mantle, but limited bare rock escarp-

ments in the Dry Creek drainage yielded fragments of dinosaur bones and teeth.

While searching for more dinosaur teeth the collectors found a mammal tooth. This impelled an even more careful examination of the sandstone and shale beds in the immediate vicinity because of the rareness of Lance mammal remains.

Several pieces of egg shell, none over an inch in length, were picked from the surface of the shale close to the tooth and also down the slope below it.

That these fragments were at one time parts of the case about a potential or actual dinosaur embryo is considered probable, though no one has reported a whole egg of this type from America and our evidence is appearance, structure and size as judged from the curvature of the preserved pieces. If they were not flattened by crushing, the whole eggs were very likely larger than the Mongolian eggs, for even the most curved portion of the Montana shell is a segment of a circle greater than the circumference of the complete Mongolian eggs. No thorough comparison has been made with those fragments in the American Museum which are labeled as being from the largest dinosaur eggs discovered in Asia, and are known only from pieces.

In external appearance as well as internal structure, the Montana shell scraps resemble some of the Mongolian dinosaur egg shells and share with them common differences from most egg shells of Chelonians, crocodilians and birds. And, true to anticipation, there are notable differences between some of the Mongolian and the Montana specimens. Deep brown, almost black, the Red Lodge shell pieces are perforated by numerous pores and are characterized externally by hillocks and valleys similar to those on some of the Asiatic dinosaur eggs. In section the mamillar zone appears thin and the pyriform zone thick. Nothing approaching a complete shell or cast of one appeared last summer but more search may reveal material that will permit a further comparison with the Mongolian specimens as well as with the eggs from Rognac, supposedly of the dinosaurian *Hypselosaurus priscus,* and change or fortify the present conclusion about the derivation of the Montana fragments.

The fortuitous association of shell fragments, probably of dinosaur eggs, and of mammalian remains has recalled the old hypothesis that dinosaur eggs were eaten by the Upper Cretaceous mammals to the extent of complete extinction of the giant reptiles. But the evidence is feeble and equivocal, and certainly this particular case of chance proximity is not valid testimony pro or con. Environmental compulsion operating upon an unwieldy group seems a more potent lethal factor for the dinosaurs than does a direct organic aggression. But no one knows with certainty why or how or with what speed they drifted out of the picture. Far from inconceivable is the prospect that dinosaur remains may be found well within the Tertiary (above the Lance) as a result of future prospecting.

The Scott Fund Expedition plans to continue the explorations in the Fort Union and Lance strata during part of next summer, concordant with the general program of geological researches which the Princeton department of geology is sponsoring in the Red Lodge area.

GLENN L. JEPSEN

PRINCETON UNIVERSITY

CONSULTANTS AT THE LIBRARY OF CONGRESS

THE resources of our great national library are well-known, particularly in the fields of law, history and economics, but the extent of its collections in the various branches of science are less generally appreciated.

With a view to facilitating the use of the library by scholars and at the same time giving the staff easier access to the advice of specialists whenever needed, a system of chairs and consultants has recently been established. In outlining the plan to the American Library Association in 1928, Dr. Herbert Putnam explained that the function of the occupant of the chair is neither teaching nor research, but interpretation. As members of university staffs, the business of specialists is to teach or to pursue intensive research of their own. In a word, to concentrate. But as members of a library staff and partaking of its spirit, their business would be to diffuse. A chair implies full-time service with some administrative responsibilities and as yet, no such appointments have been made in science. The consultant, on the other hand, is a member of the library staff on a part-time basis with no administrative responsibility, who cooperates with the staff in matters within his field, and in general, aims to make useful contacts with outside scholars, individually or collectively. Such a group of specialists in the service of the national library is a sort of informal faculty, offering to graduate students, in a measure, what is characteristic in the idea of a national university, mainly, convenient access to the principal collection of books and manuscripts in the United States and indirectly to the other extensive resources of the City of Washington.

Funds have been made available up to the present

time for the appointment of seven consultants, three in literature and history, one each in economics, sociology, philosophy and science. The first consultant in science was Dr. Alfred C. Lane, of Tufts College, in the field of geology. The present consultant is Dr. H. W. Tyler, formerly of the department of mathematics in the Massachusetts Institute of Technology.

No consultant in science will naturally undertake personal responsibility in the field as a whole, but the more modest function of acting as a medium of communication with specialists in the various fields seems within the range of practicability.

The object of this note is to make the plan better known to the readers of SCIENCE with the hope that they may be interested to communicate with the consultant, either in the sense of presenting questions on which information is desired, or offering suggestions for making the service increasingly useful.

H. W. TYLER

REPORTS

THE INTERNATIONAL GEODETIC AND GEOPHYSICAL UNION

THE World War made an unusually wide and enduring breach between scientists belonging to countries arrayed against one another in that conflict. Although geophysics is essentially an international science, strangely enough it has seemed to be precisely in connection with geophysics that the breach was apparently the widest and most enduring. The following translation from the current number of the *Zeitschrift für Geophysik* may be of interest as showing that the breach is now in a fair way to be healed. The London Manifesto, to which reference is made, was a statement drawn up at a meeting that eventually resulted in the organization of the International Research Council. It found its way by implication into the statutes of the Research Council, but all reference to it was removed in 1926.

Extract from the minutes of the general meeting of members of the Deutsche Geophysikalische Gesellschaft held at Potsdam on September 13, 1930, page 503:[1]

Mr. Kohlschütter reported on the negotiations with the International Geodetic and Geophysical Union and on the visit to the meeting of the Union held this year in Stockholm. After a thorough discussion, in which Messrs. Wigand, A. Schmidt, Weickmann, Conrad, Haussmann, Perlewitz and Tams took a chief part, the following resolutions were adopted on motion of Mr. Wigand:

(1) The meeting approves the conduct of the Executive Committee (Vorstand) and of the Stockholm delegates in regard to the International Geodetic and Geophysical Union (unanimously adopted).

(2) The meeting empowers the Executive Committee, in conjunction with the Deutsche Meteorologische Gesellschaft, the Reichsbeirat für das Vermessungswesen, the Conference of Directors of German Hydrological Institutions and the principal German institutions concerned, to prepare the way for the adhesion of Germany to the International Geodetic and Geophysical Union.

In the declaration of adhesion, it shall be stated that adhesion is made on the assumption that the London Manifesto of November 10, 1918, is considered by the Union to be unjustified.

Extract from the annual report of the executive committee of the Deutsche Geophysikalische Gesellschaft for the year 1929–1930 (from October 1, 1929, through September, 1930), page 504:

In April last, the Gesellschaft received through the London Embassy and through the Ministry of Foreign Affairs an invitation from the President of the International Geodetic and Geophysical Union to take part in this year's meeting of the Union at Stockholm. Since Germany is not a member of the International Research Council nor of the Geodetic and Geophysical Union, which is a part of it, German geodesists and geophysicists could participate only as guests. Unfortunately there was attached to this general invitation the condition that the German scientists prepared to take part should address to the President [of the Union] an appropriate request. In our answer, which was decided on at a meeting of the Executive Committee in Berlin on April 28, 1930, we expressed our entire willingness to send to Stockholm several members representing the various branches of geodesy and geophysics, but we felt unable to urge the members in question to make request for an invitation. Although, as we have learned, a number of foreign colleagues urged upon the President [of the Geodetic and Geophysical Union] the desirability of having unconditional invitations sent to the members especially designated by us for the purpose, it was not until the first day of the Stockholm meeting and after being unanimously requested by the delegates present that the President decided to send a telegraphic invitation to the German representatives. This telegraphic invitation, which was warmly seconded by the Swedish local committee, was accepted by Messrs. Angenheister, Hecker, Kohlschütter, Linke and Nippoldt. Though we took part principally in the scientific proceedings, we also took the opportunity to state our views regarding such changes in the organization of the Research Coun-

[1] Proceedings of the Deutsche Geophysikalische Gesellschaft, as reported in the *Zeitschrift für Geophysik.* VI. Jahrgang, 1930, Heft 8.

cil and of the Geodetic and Geophysical Union as we deemed necessary. It is a satisfaction to report that the newly adopted statutes of the Union, and also the statutes of the Research Council, as prepared by the Committee on Revision of Statutes of the Research Council for action at the plenary session of the Council to be held next year, are in substantial conformity with German desires, so that in the opinion of those who took part in the Stockholm meeting the way is now open for German geodesists and geophysicists to join the International Geodetic and Geophysical Union. The adhesion of Germany to the International Research Council is no longer a prerequisite to adhesion to the various unions; the question of adhesion to the International Geodetic and Geophysical Union is, therefore, laid before the members [of the Deutsche Geophysikalische Gesellschaft] for decision.

W. D. L.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

PEN AND INK DRAWINGS FROM PHOTOGRAPHS

THE ordinary method of making line drawings for publication by means of the camera lucida is tedious, especially when minute details are concerned. Photographs are frequently blurred, often do not give enough contrast or are not clear enough to be suitable for publication. The method here presented combines both the clearness of definition of the line drawing and the accuracy of the photograph. Very little seems to be known of the method in scientific fields, but it is used commercially to a considerable extent to make various types of etchings and line sketches.[1] In general, the procedure is to photograph the material, make a print on a good grade of paper and draw over it with India ink. All stippling or other shading may be done directly on the photograph. The print is then placed in solutions which bleach away the photographic image and leave the ink tracing standing out on a white background. If the original photograph is so small that details can not be drawn in easily, it may be enlarged several times, treated as above and the drawing reduced in reproduction.

The process of removing the photographic image is accomplished by two solutions. The first dissolves away the photographic image and the second bleaches the paper.

Solution 1.	Potassium iodide	15 gms
	Iodine	5 "
	Water	500 cc
Solution 2.	"Hypo" crystals	100 gms
	Water	450 cc

When the ink on the drawing is thoroughly dry, quickly immerse the print in solution 1. Rock the tray immediately so that the solution covers the print rapidly and evenly. The photographic image will disappear almost at once, and at the same time the print will become brown from the iodine. As soon as all traces of the photograph have disappeared, remove the print and wash gently in water in order to remove the excess iodine. Then place in solution 2. Here the brown color is completely lost and the print becomes quite white in about five minutes. Transfer to water and wash thoroughly to remove the "hypo." Dry the print by placing it in a horizontal position on blotting paper. It will curl as it drys, but later it can be flattened by dampening the back and placing in a press. Throughout the entire process care should be taken that nothing touches the surface on which the drawing has been made, for the ink smears very easily while wet. The iodine solution may be used repeatedly until it becomes too weak, when it may again be brought to strength by adding more iodine. The "hypo" solution may likewise be used many times.

The method has been used by the writer to make drawings of section of leaves. Microphotographs are taken on a $3\frac{1}{4} \times 4\frac{1}{4}$ inch negative and enlarged to a 5×7 inch print. The time required to take the photograph and to complete the entire process is very little more than that required to make a camera lucida drawing. After the chemical treatment no traces of the photograph remain, and the drawing stands out on a white background without any staining or blurring of the print. If desired, pencil or even charcoal may be used in place of the ink.

ERNEST NAYLOR

DEPARTMENT OF BOTANY,
UNIVERSITY OF MISSOURI

[1] J. C. Tobias, "Working up Silver Prints," *Am. Ann. of Photo.*, 44: 30–38, 1930. The writer also wishes to make acknowledgment to J. P. Barham, of the photographic service department of the University of Missouri, who first brought the method to his attention.

A METHOD OF CLEANING MICROSCOPICAL FOSSILS

ONE of the difficulties of cleaning microscopical fossils, already removed from out the matrix, is in keeping them in a desirable position under the microscope, while working on them with a needle. There is always the great danger of crushing them with forceps or of losing them when they jump out of the forceps.

In my work on foraminifera I was able, to a certain

extent, to avoid the dangers referred to through the use of the common adhesive tape. The tape was used in the form of small strips, and the whole manipulation was carried on in the following way. A tiny drop of water was put on the gummed surface of the tape, and the fossil placed on the wet spot in a desirable position. After a few minutes the glue was dried and held the fossil firmly enough to allow of its preparation. When the preparation was finished, the strip of the tape was plunged into water, the fossil removed from the tape with a soft brush and the adherent remains of glue washed off. It is very important to take as little water as possible for fixing fossils on the tape. If the drops were too large, it would not only take too much time before they would dry out sufficiently to give a good hold to fossils, but the latter might sink into the glue which, dried on their surface, would interfere with the work of the needle. The most difficult part of the operation is the fixing of the fossils on the gummed surface in exactly the desired position.

I. P. Tolmachoff

Carnegie Museum,
Pittsburgh, Pennsylvania

SPECIAL ARTICLES

AN OBSERVATION WHICH SUGGESTS AN EXPLANATION OF THE ANEMIA IN HOOKWORM DISEASE

During the course of an experiment on absorption from the small intestine of the dog in which the mucosal surface of the gut was exposed in a special device for observation of the movements of the villi, the author's attention was attracted by the activity of several hookworms (*Ancylostoma caninum*) attached to the mucosa. While watching one of them through a binocular microscope, a large droplet of blood was seen to emerge suddenly from its anal orifice. Within the next few minutes a considerable number of droplets had been ejected by the same worm. Eight or ten other worms present were all seen to be passing blood in the same manner.

The passing of blood in such quantities naturally aroused our interest, as it seems to suggest a plausible explanation of the anemia in hookworm disease. For, although anemia has long been recognized as the essential feature of the disease, its cause has remained obscure. Hemorrhagic areas, due to the bites of the worms, have been noted, and blood has frequently been found in the digestive tracts of the canine and the human forms of the parasites. Indeed, the worms have been seen to eject blood, both from the mouth and from the anus, on placing them in water after removal from the dead host. But no direct observations on the blood-sucking activities in the living host have been made heretofore, so far as the author is aware. All evidence of the presence of blood in the tracts of the worms has been considered merely as showing that blood may be the principal food of the animals. It has naturally been assumed that, as the worms can not require much blood for food and as the loss to the host by hemorrhage from the mucosa is seldom very great, there must be some other reason for the anemia. Toxins, including agents acting on the blood-forming organs or on the blood cells directly, have been postulated as possible causes. But aside from the finding of a hemolytic agent in extracts from dead worms, the evidence for such toxins has never been convincing. The observations here reported show that, in the case of the dog hookworm at least, blood may be removed from the host to a degree hitherto unsuspected, which indicates that it may be necessary to reconsider the factor of blood-sucking in relation to the causation of anemia.

Although a rather elaborate apparatus was used in the original observations, this is not necessary. The procedure may be successfully carried out as follows. A dog having a fairly heavy infestation, as shown by examination of a fecal smear for ova, is anesthetized by the administration of 0.35 gram of sodium barbital per kilo in approximately 10 per cent. solution, either by mouth or intravenously. In an hour or less the abdomen may be incised in the midline and a loop of bowel pulled out. With sharp scissors the wall of the gut is cut longitudinally on a line opposite the attachment of the mesentery. Hemorrhage from the cut borders of the segment should be checked by the application of spring paper clamps. The activity of the worms may be observed with the unaided eye and with ordinary illumination, but better results can be obtained with a Greenough type binocular microscope of low power and with the field illuminated by means of an arc or other strong source. It is advisable to keep the worms submerged in warm isotonic saline solution to prevent them from drying.

To date, several dogs have been used and some fifty worms examined, all of which were seen to be passing blood as in the first experiment. The frequency of ejection of the droplets varied considerably. In the first two dogs studied, the intervals between ejections varied from 2 seconds to 10 or 15 minutes. However, during several active periods extending over 20 minutes or more, the intervals were never longer than one

minute, the average being for two such extended periods 15 and 22 seconds, respectively. During the periods of rapid ejection the tract of the worm remains more or less distended with blood. One gains the impression that the worm gorges itself with blood before starting to eject. The red material which gradually fills the intestine may be readily seen through the transparent tissues of the worm. The anal end becomes dilated and immediately there occurs a spasmodic contraction, often of sufficient force to move the whole posterior part of the worm. A droplet appears with great suddenness from the anal orifice. It was noticed in the case of some worms that blood may finally cease to replace that ejected and that the worm may gradually become almost white or colorless. When a worm was seen to move to a new point of attachment or when it disengaged itself from a part of the mucosa to which the blood supply had been cut off it was usually white, with little or no blood visible in its tract. Some worms were observed which never became colorless during the entire day. But in these as in the others there were periods when no blood was emitted. In the case of one dog the worms observed were relatively inactive. Periods during which little or no blood was ejected lasted for half an hour or more, and both the frequency and the size of droplets during the active periods tended to be less than in the first experiments. But even in this instance there were occasionally short periods during which large droplets were emitted at intervals of less than a minute.

The color of the blood emitted was sometimes purplish like venous blood, sometimes bright red or arterial in hue. The color seemed to be a characteristic peculiar to the individual worm and hence probably dependent on the local nature of the blood supply at the point of attachment. There was no distinct evidence of any change of color, from red to blue, as the blood passed through the worm. This point may need further study, for one is impressed with the possibility that the enormous amount of blood ingested by the parasite may serve a respiratory function.

The size of the ejected droplet was estimated by collecting a single emission in a capillary pipette containing isotonic salt solution. The blood was mixed and made to a definite volume of 0.5 or 1.0 cc. The red corpuscles were counted in the usual manner. Calculation gives the total number of red cells emitted per drop. In the case of two drops, each from a different worm, there were 1,168,000 and 1,268,000, respectively. Assuming the erythrocyte count of the dog to have been 5,000,000 per cu mm, the droplets would therefore each represent the red cells from approximately 0.25 cu mm of the dog's blood. Knowing the size of the droplet one could easily estimate the daily loss of blood incurred at the expense of the host provided one knew the average rate of ejection by each worm and the number of worms present. Although the normal average rate of ejection is not known at present, one can gain an idea of the possibilities by assuming a rate of, let us say, one ejection per minute per worm, which is certainly not an excessive maximum, as judged by two experiments lasting for over seven hours. On this assumption there will be removed from a dog in this manner 1 cu mm in 4 minutes, 15 cu mm per hour or 360 cu mm per day by a single worm. With 1,000 worms present and similarly active the loss to the host would be 360 cc per day. In this calculation no allowance is made for blood cells digested by the worm, nor, of course, for blood that may be lost by direct hemorrhage at the point of attachment to the mucosa.

Although at present one can only speculate as to the actual amount of blood discharged by the worms under normal conditions, there is every reason to believe that the parasites not only can but do take in and expel much more blood than could be accounted for by their food requirements alone. As to what biological purpose is served by this process, so wasteful of the blood of the host, it is impossible at present to judge.

Although these observations do not tell us anything of the behavior of those forms of the parasite which infest man, they do suggest that the factor of bloodsucking should be reconsidered, on the possibility that this activity of the worms may be found to play a part more important than formerly suspected in the production of anemia in human cases.

HERBERT S. WELLS
DEPARTMENT OF PHARMACOLOGY,
VANDERBILT UNIVERSITY MEDICAL SCHOOL

A RELATION BETWEEN ROTENONE, DEGUELIN AND TEPHROSIN

IN a previous communication to this journal[1] it was stated that apparently the principal toxic constituents of derris and cubé roots, namely, rotenone, toxicarol, deguelin and tephrosin, were, from a chemical standpoint, more or less closely related. At the time the report referred to was made, only indirect evidence supporting the assumption was available. This consisted of the similar solubilities of the compounds in many solvents, the identity or close similarity of their empirical formulas, the fact that all contained two methoxyl groups, and, finally, their general behavior toward certain reagents.

As the study of the chemistry of these materials has

[1] E. P. Clark, SCIENCE, 71: 396, April 11, 1930.

progressed, direct evidence of a relationship among three of the compounds has been shown. The essential facts are as follows. Rotenone upon mild oxidation yields dehydrorotenone $C_{23}H_{20}O_6$. This compound when boiled with alcoholic potassium hydroxide and zinc dust gives rise to a hydroxy acid[2] $C_{23}H_{24}O_6$, which, when oxidized with hydrogen peroxide, yields derric acid[3] $C_{12}H_{14}O_7$. Derric acid contains the two methoxyl groups originally present in rotenone and represents one half of the rotenone molecule.

Upon oxidation with potassium ferricyanide deguelin $C_{23}H_{22}O_6$, the light green compound melting at 171° which is found in derris and cubé roots, the leaves of *Cracca vogelii* and the roots of *Cracca toxicara*, gives dehydrodeguelin $C_{23}H_{20}O_6$. This substance, analogous to dehydrorotenone, yields on boiling with alcoholic potassium hydroxide a phenolic monocarboxylic acid $C_{23}H_{24}O_6$, which has been called deguelic acid. Deguelic acid when oxidized with hydrogen peroxide in the same manner as was the acid from dehydrorotenone also yields derric acid.

Tephrosin $C_{23}H_{22}O_7$ when treated with a mixture of sulphuric and acetic acids or with acetic anhydride loses the elements of water and forms dehydrodeguelin. Thus derric acid constitutes one half of the molecule of rotenone, of deguelin and of tephrosin. The evidence also shows that tephrosin is intimately related to deguelin, since the loss of one molecule of water from tephrosin gives dehydrodeguelin. Without further experimental evidence, it appears probable that tephrosin is a hydroxydeguelin. Detailed reports of this work will appear elsewhere.

E. P. Clark

Insecticide Division,
Bureau of Chemistry and Soils

DISSOCIATION OF BACTERIUM GRANULOSIS NOGUCHI AND IDENTIFICATION OF THE ORGANISM BY MEANS OF RABBIT IMMUNE SERA

The viability of *Bacterium granulosis* for periods of a year or more on the semisolid ("leptospira") medium of Noguchi has already been recorded.[1] Recently, on transfer to blood agar of a culture which had stood for 8 months on semisolid medium without transfer, and which had shrunk by evaporation from 8 cc to 2 cc or less, a growth was obtained of discrete, yellowish gray, opaque, dry, bead-like colonies, with rough surface, which were distinct from the semi-transparent, grayish, mucoid, confluent colonies usually seen in young cultures of *B. granulosis*. Microscopic examination, however, showed a morphology typical of *B. granulosis*. The strain fermented the usual carbohydrates, and agglutination tests with immune sera prepared in rabbits by means of the ordinary type cultures yielded clearly positive results.

A few smooth mucoid colonies were found among the rough dry ones, and a pure smooth strain was readily isolated from one of these. Plating of rough colonies yielded a growth chiefly of the rough type, with gradual reversion to smooth within 3 or 4 days in those portions of the plate where the colonies were widely separated. Replating every 24 to 48 hours reduced the tendency to reversion until it has practically disappeared. The tendency to the formation of yellow pigment, which is ordinarily seen only in old cultures of *B. granulosis*, is much enhanced in the rough cultures and appears early. The dissociation has since been found in other strains of *B. granulosis*, the identity of which had been uncertain until they were found to be agglutinated by immune serum.

Agglutination tests have so far proved the most useful means of identifying unknown cultures, since fermentation tests may vary occasionally from strain to strain. The serum[2] is highly specific for *B. granulosis*. Fourteen known strains of the organism so far tested have been agglutinated in dilutions of 1:256 to 1:1024, while no agglutination takes place in the case of the common bacteria found in the conjunctival secretions or tissue of man or monkey (*M. albus*, *M. aureus*, *B. xerosis*, *B. influenzae*), or of numerous gram-negative bacteria from the same source.

E. B. Tilden

The Rockefeller Institute for
Medical Research, New York

[2] A. Butenandt, *Ann. d. Chem.*, 464: 272, 1928.

[3] F. B. LaForge and L. E. Smith, *Journal Am. Chem. Soc.*, 52: 1091, 1930.

[1] Tilden, E. B., and Tyler, J. B., *J. Exper. Med.*, 1930, 52, 617.

[2] The sera have been prepared by injecting rabbits intravenously at 5- to 6-day intervals with gradually increasing doses (1 cc to 5 cc) of heavy suspensions of *B. granulosis* grown on freshly prepared nutrient agar in Blake bottles.

BOOKS RECEIVED

Eaton, Allen and Shelby M. Harrison. *A Bibliography of Social Surveys*. Pp. xlviii + 467. Russell Sage Foundation. $3.50.

Giles, Albert W. *St. Peter and Older Ordovician Sandstones of Northern Arkansas*. Pp. xvi + 187. 22 figures. 13 plates. State of Arkansas Geological Survey.

Lefschetz, Solomon. *Topology*. Pp. ix + 410. 12 figures. American Mathematical Society.

The Nature Almanac: A Handbook of Nature Education. Pp. viii + 399. American Nature Association. $1.00.

Taylor, Hugh S., Editor. *A Treatise on Physical Chemistry*. Second edition.
Volume I, Pp. xv + 852 + 48. 23 figures.
Volume II, Pp. xii + 901–1766 + 48. 48 figures.
Van Nostrand. $15.00 for the two volumes.

Willey, Arthur. *Lectures on Darwinism*. Pp. 198. Badger.

SCIENCE

VOL. LXXIII | FRIDAY, JANUARY 9, 1931 | No. 1880

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SOME CHEMICAL ASPECTS OF THE ORIGIN OF PETROLEUM[1]

By Professor S. C. LIND

DIRECTOR OF THE SCHOOL OF CHEMISTRY, UNIVERSITY OF MINNESOTA

THE continuing abundance of the natural supply of liquid hydrocarbons in the form of petroleum is the modern version of the "widow's cruse" magnified to a twentieth-century scale. Little less miraculous than its abundance is the remarkable chemical complexity of the liquid mixture found in nature. No one knows the total list of hydrocarbons that compose petroleum. An old and, as it now appears, unjust charge against the petroleum industry was that it did not make sufficient efforts to learn the complete catalogue of the constituents of petroleum, multiple and variable though they were known to be.

For the past several years the American Petroleum Institute has concerned itself with the identification of the chemical constituents of certain commercial fractions of petroleum. The work has been ably conducted by Dr. E. W. Washburn, of the Bureau of Standards, and his associates. The researches which are still in progress continue to add to the evidence of the astounding complexity of even a single commercial fraction of petroleum. Several hundred fractions were obtained before the identification of a single chemical individual became possible. One of their recent achievements[2] is the proof that further fractionation is still proceeding when difference of boiling point becomes so slight (less than 0.01° C.) that it fails as a guide, while difference in index of refraction still detects progressing fractionation.

The synthesis of liquid hydrocarbons from a single gaseous member by certain methods which will be discussed later has also produced very complex mixtures. This was to be expected from the theory of the mechanism developed before the actual complexity

[1] Address of the vice-president and retiring chairman of Section C—Chemistry, American Association for the Advancement of Science, Cleveland, December 30, 1930.

[2] *Bull.* Amer. Petroleum Inst., Vol. XI, No. 53, p. 7, Sept. 12, 1930.

was demonstrated. The methods also suggested for the first time direct means of building up heavier hydrocarbon molecules from lighter ones, in contrast with the generally known process of breaking down heavy to light ones by thermal means, as illustrated by cracking.

The great chemical complexity of the liquid hydrocarbons existing in nature raises certain very interesting chemical questions as to the origin of this degree of complexity without involving directly the problem of ultimate origin. The solution offered, or the new evidence in favor of it, may, however, throw some indirect light on the larger problem. But it is really the origin of the complexity rather than the initial source of natural hydrocarbons toward which the present discussion is directed.

Evidently, one must admit either a definite chemical reactivity among hydrocarbons enabling them to spread out from a certain center consisting of one or a small number of members in both directions, higher and lower, to give the observed complexity, or else we must admit the complexity as existent from the primary origin itself.

On *a priori* grounds, the latter alternative has always appeared to the writer highly improbable, that such a variety of molecular species should all originate from a single source by any natural process in a single step either chemical or biological. If, then, a process is conceived by which a whole series of hydrocarbons can be produced from one original member by a succession of steps under such conditions as may exist in nature, such a process must appear to have the higher degree of probability.

We encounter, however, the difficulty that saturated hydrocarbons have not generally been credited with great chemical reactivity toward each other, especially not in the process of building higher from lower ones. If the organic chemist desires to add together two hydrocarbon molecules, he resorts to roundabout and most unnatural processes, such as substituting a chlorine atom in each, then removing the two halogens simultaneously by the vigorous action of a strongly basic metal like sodium, with the object of adding the two free hydrocarbon radicals together.

Since it would be impossible or highly improbable for this kind of synthesis to occur in nature, and if no simpler one could be conceived, an organic origin of petroleum from animal or vegetable sources would be favored, since an initially high molecular weight followed by thermal degradation would be required.

Let us examine the general thermodynamic relations in reactions between saturated hydrocarbons. Generally, they involve but small free chemical energy. For this reason, there is no driving force to cause interaction, and under ordinary conditions they are quite inactive toward each other. On the other hand, since there is no driving force in any direction, there is no large opposing force to be overcome; in other words, the heats of reaction are low. Furthermore, if suitable conditions are found to produce reaction, and since there are no large directing forces, one may expect reaction to take place in any direction and to proceed by successive steps in all directions, hence leading to great complexity of product, without having to assume such variety in the original source.

A thermodynamic treatment of possible reactions between hydrocarbons has been recently given by Professor H. A. Wilson[3] of the Rice Institute. Between successive members of the paraffine series in the region of temperatures of several hundred degrees and pressures from a few to several hundred atmospheres he assumes equilibria of the type:

$$2\,C_nH_{2n+2} \rightleftarrows C_{n+1}\,H_{2(n+1)+2} + C_{n-1}\,H_{2(n-1)+2}.$$

Thus there exists an equilibrium, dependent on pressure and temperature, between any member of the paraffine series and the members next above and next below in the series in point of number of carbon atoms. Since the relation is perfectly general, it will extend in both directions: to methane, ethane, at the lower, gaseous, end of the series, and to solid members at the upper end. The light gases will be either trapped, and thus furnish the gas pressure associated with petroleum, or, if liberated, will allow the dynamic equilibrium to cause a chemical drift of the hydrocarbons continuously from higher toward lower members.

Professor Wilson has pointed out that so far as his calculations are concerned, the equilibria might be purely physical ones among preexisting members of the series, but it seems quite justifiable to make the step, as he does in his later paper, "Theory of Cracking,"[4] of applying the same considerations to equilibria arrived at by chemical action. To the writer, it appears entirely logical to extend the reasoning to the processes of petroleum generation, regarding cracking and petroleum formation as entirely similar processes from the chemical standpoint, after making due allowances for such differences of physical conditions as would be necessary.

With this kind of mechanism, it would be possible then under influence of such temperatures and pressures as may quite reasonably exist in the earth's upper crust, to start with any member of the paraffine series and arrive at a liquid mixture like petroleum.

The olefine series has been given similar thermo-

[3] Proc. Roy. Soc. 116A, 501 (1927); 120A, 247 (1928).
[4] Proc. Roy. Soc. 124A, 16 (1930).

dynamic treatment by Professor Wilson.[5] It offers no new difficulties. Equilibria similar to those among the paraffines may be set up. Transition from paraffines to olefines could be effected by the elimination of methane. The treatment promised by Professor Wilson for benzene and the other ring series has not yet been given. It is an interesting question whether a transition from chain to ring members could be accomplished by inorganic processes in nature or whether the ring members originated in life processes in the primary source. While there is some evidence of the generation of benzene derivatives from paraffines by some of the vigorous agents to be next discussed, it is by no means conclusive as yet.

Besides the reactivity of hydrocarbons under the influence of heat and pressure just discussed, other more vigorous agents such as electrical discharge,[6] alpha radiation,[7] and ultra-violet light[8] have been found effective in causing them to interact. While all of the characteristics of these various types of agents are not as yet understood, they have one property in common which is rather surprising. In spite of the large quantum amounts of energy applied, the hydrocarbons are not generally broken down, but exhibit the striking property of condensation to form liquids or solids, with only so much elimination of lower gaseous members as is necessary to avoid chemical supersaturation.

Even when spectrographic evidence indicates an intermediate dissociation of high degree, as in the recent work of Harkins and Gans,[9] subsequent action leads to additional products in solid and extremely inert states.

The preciseness of the results obtained in the action of alpha rays on gaseous hydrocarbons has permitted the development of a theory of the reaction mechanism. Whether it be direct action between ions and molecules or interaction of free radicals does not concern the present discussion vitally. The predominant result is condensation of lower to higher members on up into the region of liquids and solids.[10] The theory gained from the alpha-ray studies also predicts a great variety of products both in the paraffine and olefine series. Starting from a single member either high or low should lead to all other members above and below, distributed according to some form of probability curve with its peak at the member having double the number of carbon atoms of that in the original molecule. The theory is confirmed among gaseous members, but owing to the scant quantity of liquid obtained under alpha radiation, fractionation of the liquid products has not been attempted. However, the same theory has been found applicable to liquids obtained by electrical discharge in hydrocarbons.[11] The quantities of liquid thus obtained have been sufficient to permit of some fractionation. Great complexity is revealed, as expected, and highest abundance for the molecular species with the number of carbon atoms double that of the original species; for example, octane from butane.

The application of some of these processes to the origin of petroleum may appear remote. Indeed it is so, except as the general principle may apply that when a certain type of reactions or a set of products is demonstrated to be possible through the employment of some special agent like ultra-violet light or alpha radiation, the probability becomes greater that some conditions of temperature, pressure or catalysis exist which render the same reactions possible with a lower quantum expense of energy.

Although electrical discharge and ultra-violet radiation are abundant in the earth's atmosphere, they are unknown in the crust and hence can play no rôle in synthesis of petroleum. But, not so with alpha radiation, which, due to the universal radioactivity of the crust, is everywhere present, though in very low intensity. In their original consideration of the chemical behavior of hydrocarbons under alpha rays, Lind and Bardwell pointed out[12] that feeble intensity of radiation might be so compensated by prolonged action through geological periods of time as to suggest a theory of the origin of petroleum from gaseous hydrocarbons under the influence of alpha radiation, provided two apparent obstacles could be overcome. First, are there conditions in the crust under which an appreciable fraction of the alpha radiation could be absorbed by hydrocarbons? Since the "porosity" of gas and oil sands reaches the value of 20 per cent., it seemed probable that the fraction of alpha radiation effectively absorbed in the petroleum structure might approach that degree of efficiency. The second obstacle appears more formidable. The action of alpha rays on all members of the paraffine and olefine series was found to result in the liberation of much hydrogen; whereas in all natural gases occurring in the United States, hydrogen is notably absent.

[5] *Loc. cit.*

[6] Lind and Glockler, *J. A. C. S.*, 50, 1767 (1928); 51, 2811, 3655 (1929); 52, 4450 (1930).

[7] Lind and Bardwell, *ibid.*, 48, 1556; 2335 (1926).

[8] *Stan. Tolloczko, Przem. Chem.*, 11, 245 (1927); Taylor and Hill, *J. A. C. S.*, 51, 2922 (1929); *Viktor Kemula, Rocsn. Chem.*, 10, 273 (1930).

[9] *J. A. C. S.*, 52, 2578; 5165 (1930).

[10] W. T. Richards, Proc. Camb. Phil. Soc., 23, 516 (1927).

[11] Lind and Glockler, *J. A. C. S.*, 52, 4450 (1930).

[12] *Loc. cit.*

In the purely thermal processes of Professor Wilson, liberation of hydrogen is not assumed. This alone would appear to make his mechanism the more probable. But neglecting this hydrogen difficulty, if we calculate the amount of petroleum in the earth's crust that would correspond to the present total of helium content of the atmosphere, on the basis that each atom originated in the crust as an alpha particle, a large total is arrived at. This calculation has been made by Farr and Rogers[13] on the basis of 100 per cent. efficiency in the utilization of the alpha-ray energy in producing petroleum and assuming the same yield per ion pair as found by Lind and Bardwell experimentally. The estimated total of two billion tons for the Petrolia Field of Texas is so huge that even after making large allowances for overestimation of energy utilization, yield, etc., the balance could still exceed the actual production.[14] Corrections in the opposite direction, such as possible loss of helium from the atmosphere leaving the present total content too low, and helium in natural gases still remaining in the earth would raise the total possible. The calculations of Farr and Rogers also have the advantage of being independent of any time factor. It may be mentioned incidentally that some recent analyses of natural gases in New Zealand by the same authors report as much as 4 to 20 per cent. of hydrogen in ten out of eighty-two samples, though the helium content in none of them exceeded 0.02 per cent.

To sum up, it may be said that we now know processes either thermal or ionic by which progression both up and down the hydrocarbon series is effected, starting from any member in the series. This leads directly to the complexity found in natural petroleums, as is also found in the electrically synthesized ones. Consequently, the starting material, whether of vegetable, animal, or mineral source, does not need to be a complex mixture, but may be a single chemical species, from which a high degree of complexity is obtained by steps which appear simple and natural when the chemical and thermodynamic properties of hydrocarbons are taken into account. The simplicity of such a mechanism may lend indirect support to the old idea of an inorganic origin from one or a few hydrocarbon gases such as might be produced by the action of water on metallic carbides in the earth's interior. On the other hand, it does not preclude animal or vegetable origin, but strongly suggests that the primary material, whether gaseous, liquid or solid, is later subjected to thermal (or ionic) agents (or both) which produce the complexity found in nature.

SOME RECENT ASPECTS OF NEMATOLOGY[1]

By Dr. N. A. COBB

U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

ZOOLOGICAL text-books give nemas inadequate treatment—treatment altogether disproportionate to their scientific and practical importance; the space devoted to nemas is insufficient, while many of the statements are antiquated and erroneous.

In judging this defect about 250 zoological and biological text-books printed in English were examined, including text-books proper and books often recommended to students for collateral reading.

A review of these books arouses the suspicion that the text-book treatment given the nemas instead of improving has retrograded. Certain text-books of fifty years ago, now no longer used, give this phylum better treatment than is often the case with texts of to-day.

To cover recent practice it was decided to examine carefully only latest editions. These were grouped, 32 of zoology, and 28 of biology. As a definite basis of comparison seemed necessary, it was decided to compare the nemas with the echinoderms and with the protozoa—a selection determined in part by the following consideration. A cursory examination showed that very much more space is given the echinoderms than the nemas. Since both groups are regarded as phyla and since the two groups present something near the same degree of complexity of organization and since both have long been known to science, it was thought they would furnish material for an illuminating comparison. Reasons for comparison with the protozoa will be presented later.

The percentages of text-book space given the phyla were compared, as well as the number and quality of the illustrations. The percentage of space occupied in each case was taken as a basis of comparison in order that the size of the page and of the type might safely be disregarded.

The 32 text-books of zoology devoted, on the aver-

[13] *Nature*, 121, 938 (1928); M. N. Rogers, *New Zealand Journ. Sci. and Technol.*, 11, 389 (1930).

[14] It is also to be remembered that only about 20 per cent. of the oil contained in a structure is actually recovered.

[1] Extract from the 1929 presidential address before the American Society of Parasitologists, American Association for the Advancement of Science, Des Moines, Iowa.

age, over three times as much space to echinoderms as to nemas (3.12 per cent. to 1.02 per cent.). There was a still greater disparity in the matter of illustrations—fully three times as many devoted to the echinoderms—but in addition the figures illustrating the echinoderms often were works of art—large, attractive and showing much detail, while those devoted to the nemas were sometimes the very reverse.

A moment ago the text-book treatment of the nemas was characterized as not only inadequate but antiquated. It is sincerely to be wished that criticism might end there; unfortunately it can not. In the space devoted to nemas an almost unbelievable number of misstatements occur in this series of 30 odd zoological texts in use at the present time in colleges and universities. The errors, both of commission and omission, are almost incredible, sometimes an average of 5 to 10 serious errors per page. In one or two cases there are no misstatements of fact, but in these cases, unfortunately, the nemas are almost wholly ignored.

At what may perhaps be some risk, *e.g.*, the risk of being thought a scold, I venture to point out some of these errors—about ten errors of a serious character, a dozen or more of a somewhat less serious character and errors of a minor character.

"J'ACCUSE"

(1) I accuse the authors, almost without exception, of failing to state the long-established fact that nemas moult. That all nemas moult has never been proved absolutely, any more than it has for insects, but the nemas known to moult are sufficiently numerous and varied to justify the assumption that all nemas moult, and that this is a most significant and fundamental feature of their development, which, as its details become fully known, will, in due time, doubtless aid in determining the relationship of nemas to other phyla.

(2) I accuse them, almost without exception, of failing to note the very highly significant fact that nemas do not present ciliated tissue.

(3) I accuse them of failing even to mention the spinneret, one of the most peculiar of organs, as characteristic in its way as the spinnerets of spiders. In fact a parallel omission would be a chapter on spiders ignoring their spinnerets. When this exceedingly characteristic nemic organ is absent or obscure, it is usually for the same reason as in certain groups of arachnids—degeneration due to parasitism.

(4) I accuse them of failure to note the absence of typical striated muscular tissue.

(5) I accuse them, with very few exceptions indeed, of either stating or creating the impression that Ascaris is a typical nema. This is very far indeed from the truth; it is hardly more true than that certain wingless and legless parasitic bugs are typical of all insects, or that the turtles are typical of all reptiles, or the monotremes of mammals. We know at the present time as many free-living nemic genera as parasitic, the number of known free-living species being the greater and very much the more varied. As might be expected under such circumstances, the parasitic forms show a marked degeneration of many features characteristic of the free-living forms in their own phylum—the very forms from which, according to accepted doctrine, they must have evolved. Now Ascaris partakes in this degeneration. There are very many important characters belonging to, and widely distributed in, the free-living forms of this phylum which are so nearly absent in Ascaris that they are no longer noticeable. The domination of Ascaris in this section of zoological text-books is so complete as to be something of a catastrophe in the teaching of this phylum.

(6) I accuse them—in fact they accuse themselves, for "qui s'excuse s'accuse"—I accuse them of so little knowledge of the nemic phylum, with comparatively few exceptions, as to include, nearly always apologetically, in the space devoted to nemas, organisms that do not belong there, and on the other hand excluding organisms that do belong there. There is no sound morphological reason for classing the Gordiaceae, the Acanthocephala or the Chaetognaths in the nemic phylum; yet this is still a common procedure. It is equally erroneous to exclude from the nemas the groups Chaetosomatidae and Desmoscolecidae. It would be just as reasonable to exclude the turtles from the Reptilia as to place Desmoscolex outside the nemas. Desmoscolex (and Chaetosoma) are typical nemas in a comparatively strict sense of the word; their internal organization is strictly nemic, but is masked by a modification of the exterior that has, unfortunately, led to error on the part of even noted zoologists. But these errors are of long ago and have since been again and again shown to be such.

(7) I accuse them of leaving unexplained the simple and fundamental fact that the cuticle of nemas, being non-compressible along the lateral lines, constitutes an exoskeleton, acting on which, two antagonistic systems of muscles, one ventrad and the other dorsad, effect all ordinary body movements in the dorso-ventral plane. Nemas do not, can not, move as do eels, by bending laterally.

(8) I accuse the great majority of them of omitting even to mention free-living nemas; so far as many of the text-books are concerned, the student might remain practically unaware that free-living nemas exist, and yet they constitute quite half of the known number of forms, and most undoubtedly, in many respects,

the more important half, for it is certainly correct that the true character of nemas will be fully disclosed only by a study of their more highly developed free-living forms.

(9) I accuse the majority of them not only of giving to students the impression that nemas are parasites mainly, if not entirely, but accuse them, even in presenting *this* point of view, of omitting to mention the very important fact that plants are parasitized by nemas. To show how important an omission this is, one has only to call attention to the well-known fact that the gall nema, a nemic parasite of the roots of over 700 species of plants, including most of our crop plants, is one of the worst pests known to agriculture, the annual losses from which to the world are measured in hundreds of millions of dollars. And yet this is only one of many species that infest plants. True, it is the worst of its class, but many of the others are very serious—so much so sometimes as to have ruffled international relationships and to have been the subject of laws regulating international and interstate commerce.

(10) I accuse them of misleading statements concerning the excretory system of nemas. It is regularly stated that the two lateral "lines" (meaning lateral chords) *contain* the excretory vessels, the inference being that the chords are excretory. Now it is true that in *Ascaris megalocephala* the excretory vessels lie in the lateral chords, but this is not true even of all the species that have been classed as Ascaris, for in some of them one of the lateral chords has nothing to do with the excretory vessels. In a large number of other parasitic forms the statement would not be true, while for almost all free-living forms the statement is utterly untrue. Probably the excretory vessels are not physiologically connected with the chords in any case whatever—even among parasites. The reason that the excretory system is sometimes imbedded in, or attached to, the lateral chords, particularly in some of the larger forms, is a mechanical one. This is the region in which these long tubular organs can be stowed with least inconvenience, and this is the main, and in fact probably the whole, reason for their occasional association with the lateral chords. These facts were published about forty years ago.

(11) There is no mention made of longitudinal chords or fields other than the two lateral ones, in the face of published observations to the contrary that are half a century old, observations that have been corroborated over and over again and have long been common knowledge among nematologists, and in one very large group have even long been used as characters for the separation of genera. These chords are a basic feature of the nemic anatomy—wellsprings of the cuticle.

These are serious errors. Could any one be seriously blamed for asking whether teaching them does not come too near being an imposition?

Additional Though Somewhat Less Serious Errors

Point one. Refers to the text-book statement that hermaphroditism is rare in nemas. Hermaphroditism is not uncommon among free-living nemas—relatively as wide-spread as in insects—and it is becoming known among the parasitic species. Numerous and widely varying genera of free-living nemas present species, sometimes a considerable fraction of the species of the genus, in which the males are rare or non-existent. Under such circumstances, the females develop their own sperms and these sperms are efficient, at least to the extent of inciting development of the eggs.

Point two. Either the statement is made, or it is assumed, that nemas have no locomotor organs.[2] You have already been shown the nature of the locomotor organs of numerous nemas. There no longer exists the slightest doubt that well-developed locomotor organs are present on hundreds of species of nemas belonging to a variety of genera.

Point three. Influenced no doubt by a limited knowledge of the organization of Ascaris, the statement is made that the only sense organs of nemas are papillae on the lips. Here and there, it is admitted, eyespots exist in a few forms. Now the formerly so-called "lateral organs" have been taken for chemical sense organs for a quarter of a century. They are universal in free-living nemas, and it is now becoming very evident that they are universal in parasitic nemas. It is more than twenty-five years since these organs were designated sense organs, and this idea is now so thoroughly established as to need no further comment. Phototropes of very considerable complexity, probably in some cases entitled to be regarded as organs of vision, exist in not a few of the free-living nemas—a score or more of widely varying genera. As you have been shown, these may be so complicated as to possess image-producing lenses, pigmented receptors and special nerves connecting them with the central nervous system. In addition there are tactile organs in various parts of the body, supplied with special nerves and existing in both parasitic and free-living forms, and beyond doubt universal. There are special ganglia connected with the sexual functions and these ganglia are associated with special organs, long interpreted as sense organs. There is no lack of sense organs in the nemas. How could there be?

[2] This part of the address was preceded by a lantern-slide review of the morphology and physiology of nemas.

Point four. Mainly a point of omission. The student is given very little idea of the complexity of the nemic organization. By direct statement and by omission the text encourages him to consider the nemic organism as of a simple character. Now the structure of nemas is so complicated that it is in reality one of the marvels of living organization that so many different systems of organs can be packed into a slender microscopic speck only a fraction of a millimeter long, as some are. It will be readily admitted that the late Jacques Loeb was a penetrating observer. He repeatedly said to me, "It is amazing—the complexity of the nematodes. . . . The variety of specific organization in so small a space is marvelous."

Point five. The statement is made that the life history of nemas is usually very complicated. It has become the fashion to describe briefly a few nemas that cause disease in human beings. Trichinella is often selected as an example, and, as its life history appears somewhat complicated, the assumption is made that this is typical of nemas. As a matter of fact, the life history of the vast majority of nemas is about as simple as it could be for organisms of their degree of complexity, no more complex than the life history of rotifers, or that of many animals of other groups of similar complexity. This error undoubtedly is a part of the misinformation connected with the assumption that Trichinella and other parasitic nemas are typical of the nemic phylum.

The dissections of Ascaris made in most zoological laboratories are very limited in their extent, and apparently are usually carried out by those knowing so little of the structure of nemas as to perpetuate the errors that the structure of nemas is simple and the life history complex.

Point six. An important error of omission is failure to recognize the historical significance of nemas and to use the facts of history to implant in the minds of students the historic and scientific importance of the phylum they are studying at the moment. History tells us that in the early eighteen seventies it was in a nema that the male and female animal gametes were first seen to approach each other and "coalesce" (observations of Bütschli) to form the single "pronucleus" from which alone a new individual can arise, speaking broadly. It was in the eggs of nemas that it was first shown that the "chromatin" of the two gametes after thus coming together divided in such a way that chromatin from both gametes (both parents) is distributed to each cell during segmentation, thus pointing out *for the first time* the physical basis of heredity in animals as conceived to-day (discovery of Van Beneden). Following these statements by calling attention to the classical researches of Boveri connected with the eggs of Ascaris and other nemas (the early segregation of the gonadic elements—thus disclosing the continuity of the germ-plasm, etc., etc.) is sufficient to show the extraordinarily important rôle nemas have played in the development of the science of heredity. Most important and fundamental biological discoveries were made through the instrumentality of nemas.

Point seven. It is said that the specific and generic differences among nemas are slight, in other words that those who have spent years studying the nemas are prone to make much of slight differences. As a matter of fact there is no essential difference—no difference worth discussion in this connection—between the principles guiding nematologists in ranging the nemas into species, genera, families, etc., and the principles that guide naturalists in other phyla. Nemic species are as different from each other as lions and tigers, their genera as different as cats and dogs, and so on up the taxonomic scale.

Point eight. Why continue the use of that antiquated word "worm," with all its looseness of meaning, and by its very use leading the student, perhaps unconsciously, into the assumption that things called worms have a scientific resemblance to each other—that tapeworms and roundworms and flatworms, all of them worms, have some sort of organic resemblance, justifying some sort of assemblage?

Why call any of them worms at all? We are well rid of the old subkingdom Vermes; why retain worms?

Why call nemas roundworms? They are no rounder than what are very often alluded to as worms belonging to other phyla.

Leading students even remotely to associate nemas with trematoids and cestoids may lead them to think that the structure, life history, etc., of nemas are similar to those of these other groups, when as a matter of fact there is very little real resemblance; the differences are very, very great. No doubt the statement made in more than one of the texts that the life history of nemas is usually complicated comes from this very association of nemas with other more purely parasitic groups, under the misleading denomination worms, whose life history *is* entitled to be called complicated, in that it involves regularly in all species the passage of a parasitic form through two or more conditions, forms or hosts.

Point nine. Contrary to well-established chemical knowledge it is common to state that the cuticle, egg shell, etc., of nemas is chitinous—composed of chitin. While there is a superficial resemblance between the cuticle of nemas and that of other phyla, chemists have long since established the fact that the substance mainly composing the cuticle of nemas is not chitin, and that its properties are very different from those of chitin. Among other things it quickly disintegrates

in water when once it is out from under the influence of the living nema itself. Hence the unfortunate fact that we have no fossil nemas to speak of, while fossil insects are known, sometimes in considerable detail, and from ancient strata, owing to the relative insolubility of their exoskeleton.

Point ten. Why give book room to such statements as that nemas live mainly on the juices of living hosts, when as a matter of fact nemas have learned to ingest and digest food of almost inconceivable variety? Within reasonable limits it is hardly possible to make the statement unduly strong.

Point eleven. Why harbor the thought, let alone permit its proclamation in our classrooms, that parasitic nemas show little degeneration in comparison with free-living nemas, when as a matter of fact their degeneration in this respect is practically on a par with the degeneration of parasitic forms in other phyla?

Point twelve. Authors state that nemas are entirely devoid of segmentation, in face of the fact that for a decade or more it has been established beyond peradventure that very many of them, probably the majority of the free-living forms, bear appendages that must be denominated segmented. This matter is incapable of full discussion here, but it is, to say the least, incautious to deny nemas all trace of segmentation.

Point thirteen. In these texts all the free-living forms are still placed in one or only a few families, *e.g.*, Anguillulidae, when as a matter of fact it has long been common knowledge among nematologists that they belong to a wider range of families than do the parasitic nemas.

Most of these additional thirteen errors are also serious ones.

MINOR ERRORS

One text at least continues the mistake of regarding the esophageal swellings as stomachs, or organs for trituration, and even on occasion of calling them "gizzards."

At least one text places the central nervous system at the anterior end, instead of around the esophagus.

The longitudinal chords are called "thickenings of the epidermis" at the same time that they are said to *include* the excretory system, whose embryonic origin is entirely different from that of the epidermis.

Not infrequently the texts treat the nemas as constituting a group of lower order, instead of, as they do, constituting one of the most outstanding phyla of which we have knowledge.

I have come across other misstatements which, though they are not common, are worthy of mention. Nemas are said to be cylindroid and to taper at the two extremities. Among the free-living forms, which, as before remarked, constitute at least half the present known forms, this description of Ascaris applies but poorly. While it is true that they often do taper more or less toward the extremities, not infrequently this is not at all a marked feature, especially in front, and one which in a general description would be ignored. Furthermore, there are large numbers of nemas to which the term cylindroid is totally inapplicable; some are spherical or nearly so, many are much wider toward the extremities than they are in the middle. No doubt those who derive their idea of the form and motion of nemas from Ascaris alone think that all nemas have a serpentine motion. Their movements are *always draconic,* never serpentine. A large number of nemas, hundreds of species, numerous genera, creep after the manner of the caterpillar popularly known as the inchworm or measuring worm, as shown in some of the slides exhibited.

I note a good many misapplications of generic and specific names, but we know so little about the details of this phylum as yet that it is premature to attempt any final or even fairly satisfactory philosophical classification. The classifications necessarily proposed must be looked upon as matters of more or less ephemeral convenience, and usually not as adequate expressions of zoological philosophy. Probably the total number of species now described does not much exceed 5,000, belonging to from 900 to 1,000 genera, distributed about equally among the free-living forms and the parasitic forms. When we consider that those who have given the closest attention to the matter believe the species of nemas existing must be numbered in at least hundreds of thousands, and when, in addition to this, we consider that the great majority —fully nine tenths at least—of the forms that have been seen, studied and named are inadequately known, it becomes evident how futile it is, at the present time, to make strenuous attempts to institute a philosophical classification. Inasmuch as nematologists themselves have come to no very satisfactory conclusion in regard to the more comprehensive taxonomic groups, it is quite forgivable to writers of zoological text-books that errors of this sort occur.

I am not unaware of the difficulties in teaching nematology as it should be taught, nor inexperienced in the matter, having as a teacher actually used nemas in courses in school and university. The difficulties are mainly connected with their small size and the fact that their organs, highly varied though they are in function and form, are reduced to extremely small size and packed into extremely small space. Their study and demonstration therefore require skilful use of the microscope. At one time this would have been

a serious matter. Microscopes of the quality and number necessary for the purpose would have been expensive and difficult to procure. This difficulty has been largely decreased, and we now find microscopes used with more skill than formerly in zoological laboratories, especially in conjunction with protozoology and cytology.

It is for this latter reason that a comparison is now drawn between the treatment given in these same text-books of zoology to nemas and to protozoa. Not because the two groups are morphologically comparable; the comparison is much less apt than the comparison between nemas and echinoderms. It is made for the purpose of showing, among other things, that it is impossible for teachers of zoology longer to plead that it is the small size of nemas and the necessity of using microscopes skilfully that have brought about the condition criticized. If these difficulties can be overcome in connection with the protozoa, there would seem to be no reason why they can not be overcome in the case of nemas. The comparison will show—particularly through the nature of the forms selected by authors to illustrate respectively the nemas and the protozoa—that such an excuse will no longer hold.

As might be expected, the average space given the protozoa is more than five times as great as that given the nemas, and the illustrations outdo both in relative number and quality those devoted to nemas, that is to say there are more than five times as many illustrations given under the head of protozoa as under the head of nemas, and they are better.

A careful examination of the illustrations shows that the microscopy necessary for the production of these particular protozoan illustrations is practically of the same nature as that required for a study of the nemas. Hence if we assume that along with the zoological texts, corresponding laboratory work is done, and done satisfactorily, we must assume that in protozoological laboratories microscopes are used with that degree of skill and painstaking care necessary in connection with nemas.

The twenty-eight text-books on biology gave figures very closely comparable with those obtained from text-books on zoology.

The figures and facts presented indicate an opinion on the part of those who prepare text-books of zoology and of those who teach zoology that there are stronger reasons for acquainting students of zoology with echinoderms than with nemas. Let us compare these two phyla (1) with respect to their economic importance, (2) their historical importance, (3) their importance as furnishing suitable material for teaching purposes.

Economic importance. We have already seen, in connection with the lantern slides shown, something of the great importance of nemas as causing diseases of man and his domesticated animals and plants. It is quite impossible to go into detail here, but a few items will be mentioned that show the enormous importance of this phylum in this respect.

For example, I am authoritatively informed that of the approximately twenty-one and one half million dollars the Rockefeller Foundation has spent on public health activities, *excluding buildings, equipment* and endowment, over one fourth has been spent on what is known as hookworm control. Many government agencies in many lands have contributed cooperatively large additional amounts to the same end at the same time. I leave you to calculate the probable losses to mankind through this single nemic disease, to cause such a huge, world-wide expenditure in an attempt to ameliorate it. In doing so it is well to remember that this is only one of over a hundred distinct species of nemas known to infect the human body.

My colleague, Dr. M. C. Hall, estimates the livestock losses in the United States through the attacks of nemas to be not less than one hundred million dollars per annum.

You have already heard of the huge crop losses to agriculture due to the attacks of the gall nema.

The oft-repeated statement is amply justified, that nemas are responsible for annual losses aggregating very many millions of dollars, and for death, suffering and inefficiency on a large scale among human beings and their domesticated animals and plants.

To offset all this I am glad to say I know of no echinoderm causing a serious disease of human beings, or of a domesticated animal or plant. The economic losses due to echinoderms are confined to the depredations of predatory forms, and even here the list is not very impressive. The marine shellfish industry, or at any rate the oyster industry, suffers locally, at times severely, from the attacks of starfish, but if the entire marine shellfish industry were thus wiped out, the loss would not be equivalent to any one of many single items connected with nemic diseases.

Let us now consider the balance on the other side. It is not so widely known as it should be that there are beneficial nemas, that is, nemas beneficial to mankind because they are active enemies of other organisms which on their part are injurious to mankind. We are only at the beginning of these important lines of research, and yet investigations have already shown that the prevalence of a number of very injurious insects is largely dependent upon whether or not they are parasitized by certain nemas. The nemas are such an important factor in the prevalence of some of these insects as to appear second only to the reproductive powers of the insects themselves, and in some

cases it is becoming rather difficult to see how human beings could live in comfort in certain regions now thickly populated were it not for the beneficent effect of certain nemas.

Benefits from echinoderms are practically confined to one item, the value of trepang, or bêche-de-mer, a food—more or less of a luxury—used in the East. The total value of the trepang industry, which is said to employ hundreds of vessels, is a figure I have been unable to obtain with exactness, so I resort to liberal estimates. If we place the entire fleet engaged in the industry at a thousand vessels, which I believe too high, and the average annual value of the catch of each schooner at $10,000 per annum, which is probably in excess of reality, the total annual valuation of the catch would be $10,000,000. The trepang actually fished from the Great Barrier reef, by far the largest fishing ground, is given by the Queensland government as about 33,000 pounds sterling per annum, say $155,000, and from this I am inclined to think the estimates given above too large. The trepang fished on the Pacific Coast of the United States, 1927, is given by the Bureau of Fisheries as 5,355 pounds, valued at $268.

Historical and scientific importance. In comparing the relative historical and scientific importance of nemas and echinoderms, I can hardly do better than refer to that classical work, Wilson's "The Cell in Development and Heredity," a work of broad scope dealing comprehensively with what constituted the main biological work of the late nineteenth and the early twentieth centuries, a work by general consent placed in the very first rank.

If the reader of this work will consult its index to authors, he will find that few if any authors are more frequently and extensively quoted than Van Beneden and Boveri. Remove from the text the passages and illustrations derived from these particular researches of these two authors, and the very heart would be taken out of the work. If now one inquires what were the organisms used by these men in their epoch-making discoveries he will find that they were very largely, in fact in many cases almost exclusively, nemas. It would be difficult to conceive more convincing evidence of the great historical importance of nemas as contributory material for some of the most fundamental biological researches of the last 50 years.

Very many important researches, and many of a basic character, have been carried out with the aid of echinoderms, but the conclusion seems unavoidable that up to the present, in fundamental biological research, they have not been as important as the nemas.

Relative importance of nemas and echinoderms as a source of laboratory material for teaching zoology. Many echinoderms are of large size and are readily collected, preserved and shipped. In their living condition they are interesting and often attractive objects. Where running sea water is available, the study of their gametes, fertilization and early development is fascinating and highly instructive work. A practical disadvantage is that they are marine only.

One can therefore understand why echinoderms have received some of the attention remarked upon in this review of zoological texts.

The nemic laboratory material currently used in our zoological courses suffers severely by comparison. In fact, it is rather difficult to imagine a more uninteresting, not to say disgusting, object to be placed in front of, say, a dainty and refined girl student than *Ascaris*, so stimulative of disagreeable feelings and thoughts, and devoid of a single curious or interesting external feature to attract attention.

Fortunately, however, it is not necessary to introduce nematology to students by way of *Ascaris*, although at present any other course is little heard of in our schools and universities. There is a large assortment of extremely interesting microscopic nemas that can be placed before the student in a living state—nemas both free-living and parasitic—and when this is done with the aid of good microscopy there is in my personal oft-repeated experience never any lack of interest, or even enthusiasm, on the part of students, whether they be new to biology or already considerably advanced.

This successful and attractive way of introducing live nemas to students can be carried out almost anywhere, but necessitates good microscopy and involves certain comparatively simple technique long used in certain laboratories. Through this change in material and methods, the nemas may easily be made so attractive as pedagogically to compare favorably with other organisms.

Whatever the method of comparison adopted, we are unable to come to a conclusion justifying the present relatively small amount of space and time assigned to nemas in zoological texts and courses. The emphasis seems so obviously misplaced as to lead to the following constructive suggestions.

(1) Rectify those egregious errors with regard to nemas. Most of them are no longer excusable.

(2) Cut down the space and time devoted to, say, echinoderms, by 50 per cent. or more and add them to the nemas.

(3) Teach nematology through the instrumentality of living, microscopic, transparent forms, especially the free-living ones, and relegate *Ascaris* to the background so far as morphology is concerned.

These suggestions are brief but comprehensive. Probably the greatest obstacle to their immediate

adoption is the fact that so few trained zoologists know anything worth speaking of concerning nemas. It is suggested that trained zoologists can instruct themselves by a perusal of original nemic literature (not text-books—not encyclopedias) available in most large libraries, and by a few weeks study of living nemas with the aid of high-power immersion lenses. The nemas should be under sufficient pressure to prevent active motion, but not sufficient to altogether prevent them from moving.

THE CHALLENGE OF PLANT VIRUS DIFFERENTIATION AND CLASSIFICATION[1]

By Professor JAMES JOHNSON and Dr. ISME A. HOGGAN

UNIVERSITY OF WISCONSIN AND U. S. DEPARTMENT OF AGRICULTURE

For some time there has been no phase of phytopathology in greater need of cooperative thinking and action than that of plant virus differentiation and classification. Much uncertainty and confusion have existed in this field of investigation ever since the first recognition of a virus disease by Adolph Mayer in 1886. Soon after Mayer's work became known, it was claimed by some that his "Mosaikkrankheit" of tobacco included two distinct diseases, one the true infectious mosaic and the other a supposedly unrelated necrotic disease known elsewhere as "Pockenkrankheit." Although much attention was given to the subject, this disagreement has persisted almost to the present time, though it is now quite generally conceded that Mayer was correct in his interpretation that necrosis is one of the symptoms of the ordinary tobacco mosaic virus on tobacco as well as on certain other hosts.

In the meantime, the continued description of virus diseases on different hosts, on the basis of symptoms only, has led to serious confusion even in fundamental research concerning the nature of a virus. It was natural that a school of thought should develop which was inclined to the belief that only one, or at the most only a few, viruses existed in nature, or that a virus was a labile entity capable of adapting itself to various hosts and circumstances. This point of view has only recently been dispelled by those who maintain that many distinct and specific viruses exist in nature and that we have in the viruses a problem of differentiation and classification comparable in complexity if not in extent to that in mycology and bacteriology.

Unfortunately, however, the pendulum is apparently swinging too rapidly in this direction. The tendency to apply new names to a virus disease when only symptom expression is involved, either on an old or on a new host, is leading to new difficulties, the more serious because we are dealing with an unseen entity, the true nature of which may long remain a mystery.

The challenge is clearly before the workers on plant viruses, first, to check themselves and others as far as possible from adding to our present difficulties, and then to clear up as rapidly as may be done the confusion already existing in the literature.

While the reliable methods now available for the differentiation of plant viruses are not applicable in all cases nor entirely satisfactory in others, such methods are yet remarkably useful considering the early stage of development of this subject. New and better methods for the differentiation, determination and description of specific viruses are gradually becoming available, and important advances in this line of technique may be looked for in the future. Many of these methods are already familiar to most of the workers. In connection with a discussion of this kind, it may be well briefly to list the more obvious of these methods and to discuss their possibilities and their limitations.

Four chief types of differential or diagnostic features of plant viruses are recognized at the present time. These are: symptom expression, properties of the virus, modes of transmission and the cytological picture.

Symptom Expression

Comparative symptoms on a single host species or variety have constituted the main diagnostic character relied on up to the present time in the recognition of specific viruses. The best example of the use of this type of differentiation lies of course in the potato virus group. The limitations of this method, useful as it has been in the past, are obvious to any one who has worked with this group of diseases. The symptoms produced may vary greatly with the variety of potato and its stage of development, and with the source and method of infection as well as with the environment. Consequently, descriptions of symptoms of the different viruses often overlap so extensively as to be quite unreliable even to authori-

[1] Paper read before the Section of Mycology and Plant Pathology of the Fifth International Botanical Congress at Cambridge, England, August 20, 1930.

ties on the subject, who may unconsciously depend rather upon recognition through acquaintance than through description. However, all that is distinctly useful in this method of differentiation should be retained, but there is much in the way of detailed description which could advantageously be dispensed with.

The use of comparative symptoms on a range of different host species or varieties is a diagnostic character which has been less commonly used than the possibilities appear to justify. It is fundamental to the progress of virus investigation to know something of the host range of each virus, and where the host ranges are distinct, or even where the symptoms are distinct on some hosts although not on others, a good basis for differentiation or determination exists. It must be admitted that, in general, the use of the differential host method up to the present time has often served to confuse rather than to simplify our problem, but we believe that, with new facts which have been brought to light, the situation will soon be reversed.

A third group of differential factors which warrant consideration in the present connection is that of environmental influences, such as the effect of temperature on symptom expression. The remarkable influence of temperature on the symptom expression of certain potato viruses is now well known. Temperatures which may mask one virus disease may intensify the symptoms of another, as, for example, in the case of crinkle mosaic and rugose mosaic of the potato, using Schultz's terminology. This characteristic may consequently be of considerable value in the determination of these and other diseases where other more simple or reliable methods may not be at hand. In any case, factors of environment and other related circumstances, such as vigor and stage of development of the host, need to be taken into consideration in any attempted determination or description of a virus disease on the basis of symptom expression.

Properties of the Virus

The properties of the virus itself seem to offer the most reliable and satisfactory characteristics for differentiation of certain viruses of the true mosaic type, or of those viruses which are quite readily artificially inoculable from plant extracts, as distinguished from those transmissible only by insects or by grafting, which are commonly of the "yellows" type of virus disease. Remarkable differences exist between these mosaic viruses with respect to the length of time they may survive in plant extract or apart from the living host. It is necessary only to call attention to the tobacco mosaic virus, which may apparently live outside the living host for as long as twenty-five years under certain conditions, in contrast to a certain potato mosaic virus which apparently becomes inactivated in two to four hours. Similarly, tolerances to dilution may vary from 1 to 10 to 1 to 10,000 or more with different viruses, and thermal death-points from 40° C. to 90° C. Corresponding variations in reaction to treatment with chemicals of various sorts are also known to exist, although this field as a means of virus differentiation is as yet relatively unexplored.

Not only are these properties of great value for diagnostic and descriptive purposes, but they may often serve, especially in combination with the use of differential hosts, as a ready means of separating combinations of viruses into their component parts. We have here a beginning of the technique for the isolation of what might be called "pure cultures" of viruses, which, followed up with some modification of Koch's postulates, may eventually place the determination of the mosaic type of virus disease on quite as sound a basis as that now available for diseases of bacterial origin.

Modes of Transmission

The third means of differentiation of plant viruses, which merits more consideration than has been given to it from this point of view, is that of differential modes of transmission. We may pass over with bare mention the fact that it is possible in some instances to differentiate viruses by their behavior with respect to the source from which the inoculum is taken, and the method of inoculation used. Tobacco mosaic, for instance, is not recoverable from certain host plants although these may be readily infected with the disease; and Dr. Goss has shown, for example, that the spindle-tuber disease of the potato is transmissible by the cutting knife, whereas the common mosaic viruses of this host are not. Obviously, many viruses may be distinguished on the basis of their differential transmissibility through budding or grafting, insect vectors and virus extracts.

More interesting, however, and possessing greater possibilities for expansion within closely related groups is the isolation and differentiation of plant viruses through their specificity in insect transmission. The development of a method of differentiation on the basis of their insect relationships, particularly with respect to those viruses which are not readily transmissible by artificial means, may eventually serve to complete a satisfactory key for the determination of plant viruses in general. Our knowledge of this field is already sufficient to indicate that we are dealing here with at least three specific conditions affecting the transmissibility of a virus by an insect, namely: (1) The species of insect

involved; (2) the specific virus concerned; and (3) the species of host plant serving as a source of infection. It may also conceivably develop that the species of host plant serving as "suscept" may add to the possibilities of differentiation.

In some cases, at least, a highly specific relationship is known to exist between the virus and its insect vector. Certain diseases of the "yellows" type appear to be transmissible by a single species of leafhopper only, and, so far as is known at present, by no other type of insect; curly top of sugar beet by *Eutettix tenellus;* aster yellows by *Cicadula sexnotata;* and streak disease of maize by *Balclutha mbila.* Although the host ranges of the first two diseases are wide and may overlap to a certain extent, this specific relationship offers a ready means for the isolation and determination of the respective viruses concerned. Again, of the virus diseases affecting the raspberry, for example, the aphid *Aphis rubiphila* is said to spread curl only, and the aphid *Amphorophora rubi* the mosaic diseases only; and other examples may be quoted of different viruses which may affect the same host plant, each dependent upon a different specific insect carrier for its transmission.

It has furthermore been shown that cucumber mosaic is readily transmissible from tobacco by several different species of aphid, while ordinary tobacco mosaic is not so transmissible. Here again is a means of differentiation and a simple method for the separation of the two viruses involved should they occur in combination.

Only a single example may be cited at the present time of the influence of the host species serving as the source of infection on the transmissibility of a virus by an insect. The aphid *Myzus pseudosolani* is apparently unable to transmit the ordinary tobacco mosaic virus from tobacco and certain other solanaceous hosts, yet it will readily transmit this same virus from tomato. Although no adequate explanation of this peculiar host relationship can be offered at the present time, it is evident that here, at least, the species of mosaic host plant may exert a determining influence on the amount of insect transmission of a particular virus. Whether or not this is an entirely exceptional case, however, remains to be determined.

On the other hand, the relationship between insect and virus does not always appear to be so specific. Cucumber mosaic, for example, is said to be transmissible by at least five different species of aphid, as well as by two species of cucumber beetle. Further, the peach aphid has been reported as transmitting a number of different virus diseases, such as spinach blight, various potato mosaics, potato leafroll, lettuce mosaic, sugar-beet mosaic, celery mosaic, bean mosaic, and mosaic of Chinese cabbage, mustard and turnip. Although it has not yet been shown that the various diseases just named are actually due in all cases to different, specific viruses, our knowledge of some of them being practically confined to the symptomatology on a single host, yet several of these are definitely recognized as distinct; and it would consequently appear that the differentiation of viruses by means of certain insect vectors may be somewhat limited in its application.

THE CYTOLOGICAL PICTURE

The fourth and last type of differentiation which we wish to mention is that of the cytological picture in the virus-affected tissues. This method is, of course, often used in the determination of certain animal viruses, although it has not yet been extensively developed for the plant viruses. It has been shown that the so-called "x-bodies," or vacuolate inclusions, are invariably associated with the tobacco mosaic virus regardless of the host on which it exists, provided that mottling or chlorotic symptoms are produced, but that they are not found in the case of the cucumber mosaic virus and certain other viruses on the same hosts even though host mottling may occur. The cytological picture of the potato viruses has hardly been studied sufficiently to warrant any definite conclusions, but we suspect that the details differ here also with certain different viruses. Characteristic cell inclusions are known to be constantly associated also with certain other plant virus diseases, and these may eventually prove to be a valuable diagnostic feature.

The usefulness of the cytological method will, of course, depend upon whether or not any simpler, quicker or more convenient means of differentiation exists where determination is required. The suggestion is merely put forward that cytological technique may eventually prove to be the best method of differentiating two or more specific viruses which are otherwise closely similar.

By the use of the various differential characteristics which we have now discussed, it has already been shown in certain instances that virus diseases of various hosts described in the literature are, or may be, due to one particular specific virus. The cucumber mosaic virus has, for instance, been shown to be the causal agent of mosaic diseases of a number of host species, where this relation was not suspected when the diseases themselves were originally described. There is room for considerably more reduction in synonymy than has so far been achieved. On the other hand, there has been, and there no doubt will be, a growing list of specific plant viruses

adequately described and accepted on both old and new hosts. The first challenge now before us is, however, whether there is any justification for a person to describe and name a virus disease on any host without adequately and thoroughly subjecting the virus concerned to a sufficient number of the differential tests available to ascertain whether or not the virus or the disease in question should be given a new name.

In America this problem of the promiscuous application of new names to virus diseases on the basis of symptom expression only has become so serious that it is generally felt that some concerted action should be taken for the protection of the virus workers themselves, as well as of those of the teachers and students of the future who may be obliged to cope with the subject. A strong feeling existed, therefore, at the last meeting of the American Phytopathological Society that it would be well to have a group of pathologists assigned to consider ways and means of reducing the difficulties before us. The initiative in this direction, to be most effective, should come rather from an international body of pathologists. A closely related phase of the subject of virus differentiation is the standardization of the requisite technique. Manifestly, a uniform procedure should be adopted in the determination of the properties of virus extracts. We are also obliged to recognize that the source of the inoculum itself with respect to the host species or variety as well as to other conditions may have a bearing on the results obtained. Finally, it must be recognized that the host plants to which the inoculum is applied may respond differently according to their age and vigor and to the surrounding environmental conditions. The subject of standardization of technique is one in which a good beginning could be made by the selection of some international group to help lead the way.

We are perhaps not yet sufficiently far advanced to go far into the field of strict classification of the plant viruses. Those of us who have attempted to comprehend the viruses as a group, however, are impressed by the fact that we appear to have several closely related classes or forms which may be compared to species of a single genus, while other groups of viruses are as distinct, certainly, as the most widely separated groups of bacteria. The development of a system of classification for the viruses seems to be almost inevitable in the near future, while this is at the same time a matter in which we can afford to move slowly.

The adoption of a uniform system of nomenclature for the viruses would prove to be highly desirable to the students of the subject. There appears to be no serious obstacle in the way of some satisfactory international agreement on this subject. Several proposals have already been made in the literature, but we wish to point out here that the effort should be fundamentally in the direction of naming the virus rather than the disease which it causes. In practice we may never overcome the synonymy and confusion of the common names of plant diseases, but there is no good reason why a single technical name should not be made to represent a specific disease-producing entity.

We have purposely taken this unusual opportunity to make such an appeal, rather than to present actual details of results and conclusions in this field of investigation. If the challenge of virus differentiation problems is to be met, we are convinced that nothing more helpful could come about than for some international body to come to some agreement on a system for plant virus differentiation, classification and nomenclature, and to use its best influence to secure the universal adoption of such a system or standard as will eventually place the subject of plant viruses in a position commensurate with their importance in the sciences.

SCIENTIFIC EVENTS

VIVISECTION IN ENGLAND

A BILL has been introduced in the House of Commons by Lieutenant-Commander Kenworthy to prevent the application of public moneys to vivisection experiments. The measure is a subsidiary bill promoted by the British Union for Abolition of Vivisection, and was previously before Parliament in 1922 and 1924, according to the London *Times*.

The British Medical Association is opposed to the bill and has addressed a letter to members of Parliament in which it is pointed out that the Act of 1876 lays down that no one but the holder of a license from the Secretary of State is permitted to use animals for experiments; that such work shall only be carried out at registered places; and that the experiments must be performed with a view to the advancement of physiological knowledge or of knowledge which will be useful for saving or prolonging life or alleviating suffering.

The letter of the association continues:

> This work is loosely termed vivisection, but no severe cutting operation is permitted under the Act without the use of an anesthetic of sufficient power to prevent the animal feeling pain. Very many of the so-called ex-

periments permitted under the Act are done for the routine purpose of public health or of medical treatment for the immediate benefit of the community or individual patients. The potency of many remedies in use to-day, notably glandular extract, vaccines sera, and some drugs, such as arsenicals (*e.g.*, salvarsan) can not be determined except by animal experiments. Without being so tested they may be uselessly weak or dangerously strong. Lives depend upon these powerful medicaments being of standard strength.

Should the expenditure of public money on such work as this be prohibited? Pituitary extract is a good example. It is a valuable drug in childbirth, often diminishing pain and danger and obviating the use of instruments, but an overdose might easily kill the patient. Before proper control was introduced, different preparations on the market varied in strength up to as high a ratio as 80 to 1 with results that can be imagined. By means of animal experiments a standard of potency, expressed in definite units, has been secured, and is, in fact, now enforced by law. This is one of the national biological standards for which the Medical Research Council is responsible. Some infectious diseases, *e.g.*, some cases of tuberculosis, can not be diagnosed with certainty except by animal tests, and animals must of necessity be used in the preparation of certain vaccines and sera. It is a public duty that such work as this should be carried out, and in some cases the law requires it to be done. The effective control of therapeutic substances can only be ensured by the state, and therefore by the expenditure of public funds. It is not always realized that the term vivisection covers such work as this, and the British Medical Association is of opinion it is in the interests of the community that Commander Kenworthy's Bill should be opposed.

REORGANIZATION OF THE NATIONAL PARKS ASSOCIATION

AT a special meeting on December 5, 1930, the Board of Trustees of the National Parks Association was reorganized by election of members appointed by twenty-two leading scientific and conservational organizations, and unanimously adopted the following statement offered by Dr. John C. Merriam and seconded by Dr. Wallace W. Atwood, president of the association:

The National Parks Association should be so organized as to speak with the authority of accurate knowledge on problems touching use and future development of National Parks. It should consist of representative individuals and representatives of organizations in a position to see the great problem of the parks from the point of view of physical, emotional, intellectual and spiritual values. It should be a body able to think park problems through, and give accurate and sound expression of judgment on these questions. Among other matters, it should devote itself to:

1. Study of the future function and use of National Parks as a guide in determining how to maintain the proper balance between protection of primitive features in the parks and development of these areas for the purpose of making them accessible to the people.

2. Consideration of future growth of the National Park System on the basis of clear understanding of its use and function. What should be the relation of this system to city parks, state parks, state forests and national forests? What types of areas should be included, and why? What methods should be used in securing new park areas?

On December 24, the following study committees were appointed:

To study future functions and use as stated in the first of the two problems above: Dr. Frederick V. Coville, Mr. Charles W. Eliot, 2d, Dr. Vernon Kellogg, Mr. Duncan McDuffie, Mr. Frederick Law Olmsted, Dr. Victor E. Shelford, Dr. Fred E. Wright and Dr. Wallace W. Atwood, chairman.

To study growth, relationships, types and methods of creation as stated in the second problem above: Mr. Albert W. Atwood, Dr. Theodore S. Palmer, Dr. Henry Baldwin Ward, Mr. David White and Mr. William P. Wharton, chairman.

The new Board of Trustees consists of twenty-two members appointed by prominent associations interested in the attainment of the highest purposes of the National Parks System, and fifteen members at large. Representatives of organizations are:

Otis William Caldwell representing the American Association for the Advancement of Science.

Morse A. Cartwright representing the American Association of Adult Education.

James McKeen Cattell representing the National Academy of Sciences.

Allen Chamberlain representing the Appalachian Mountain Club.

Guy N. Collins representing the American Society of Naturalists.

Frederick V. Coville representing the Botanical Society of America.

William B. Greely representing the Camp Fire Club of America.

George H. Harvey, Jr., representing the Colorado Mountain Club.

Augustus S. Houghton representing the American Game Protective Association.

Vernon Kellogg representing the National Research Council.

George F. Kunz representing the American Scenic and Historic Preservation Society.

Charles Riborg Mann representing the American Council on Education.

Duncan McDuffie representing the Sierra Club.

Frederick Law Olmsted representing the American Society of Landscape Architects.

Theodore S. Palmer representing the American Ornithologists Union.

T. Gilbert Pearson representing the National Association of Audubon Societies.
Arthur Stanley Riggs representing the Archeological Institute of America.
Victor E. Shelford representing the Ecological Society of America.
Mrs. Katharine B. Tippetts representing the General Federation of Women's Clubs.
Henry Baldwin Ward representing the Izaak Walton League of America.
William P. Wharton representing the American Forestry Association.
David White representing the Geological Society of America.

Besides the representatives of other organizations, the reorganized board contains these fifteen trustees at large: Truman Abbe, Albert W. Atwood, Henry W. de Forest, Charles W. Eliot, 2d, Joshua Evans, Jr., Francis M. Goodwin, Caspar W. Hodgson, Walter Bruce Howe, John C. Merriam, John Barton Payne, George E. Scott, Mrs. John Dickinson Sherman, Fred E. Wright and Robert Sterling Yard. Former trustees will be found scattered among both groups, most of them in the latter.

The wholesome relationship of public lands of all uses, of which the National Parks System is one, is the concern of this association, and the preservation of the rare remaining primitive in its safest form of administration is a prime objective.

ROBERT STERLING YARD,
Executive Secretary

THE BOWDOIN INSTITUTE OF NATURAL SCIENCE

BOWDOIN COLLEGE at Brunswick is planning to open on April 7 an institute of natural sciences. The institute will be the fifth in a series begun in 1923, when the subject chosen was "Modern History," and continued at intervals of two years with "Modern Literature," "Art" and "The Social Sciences." The institutes have sought to bring to the student body, the community and the friends of the college an opportunity to hear something of the problems which claim the attention of the leaders in the several fields of activity represented.

Plans for the coming season have been in the hands of a faculty committee under the leadership of Professor Manton Copeland, of the department of biology. Nine speakers will come to the college for the institute, which will occupy about two weeks and will be opened on April 7. Specific fields of science to be represented are astronomy, biology, chemistry, geography, geology, medicine, physics and psychology.

Professor Julian Huxley, English writer and scientist, was the first speaker in the institute group. He spoke at Bowdoin on "Development, Heredity and Evolution."

Dr. Harlow Shapley, director of the Harvard College Observatory, will talk at the April sessions on "The Cosmic Panorama." Professor Kirtley F. Mather, of Harvard, will speak on "Sons of the Earth: The Geologist's View of History."

Professor Dayton C. Miller, of the Case School of Applied Science at Cleveland, will present "Demonstrations on Visible Sound." Professor George H. Parker, Harvard University, will lecture on "The Cost of a Thought." Professor Edwin G. Boring, also of Harvard University, will discuss "The Rise of Scientific Psychology."

Professor Charles H. Herty, of New York, former president of the American Chemical Society, will speak on "Chemistry's Service in the Promotion of Industrial Research in America." Dr. Isaiah Bowman, director of the American Geographical Society, will speak on "The Invitation of the Earth."

Dr. Florence R. Sabin, of the Rockefeller Institute for Medical Research, will have as her topic "Recent Studies of the Chemistry of Bacteria as Applied to Disease." Professor Edwin G. Conklin, of Princeton University, will be the second speaker in the field of biology.

OFFICERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A FULL report of the Cleveland meeting of the American Association for the Advancement of Science and the associated scientific societies will be printed in SCIENCE as soon as the permanent secretary is able to arrange the material. Dr. Franz Boas, professor of anthropology at Columbia University, was elected president, succeeding Dr. Thomas Hunt Morgan, of the California Institute of Technology. Dr. C. F. Roos, assistant professor of mathematics at Cornell University and secretary of Section K, was elected permanent secretary to succeed Dr. Burton E. Livingston, professor of plant physiology at the Johns Hopkins University, who becomes general secretary. Professor Charles A. Shull, University of Chicago, was elected secretary of the council to succeed Professor Sam F. Trelease, of Columbia University. Vice-presidents and chairmen of the sections were elected as follows:

Section A (Mathematics), Dr. Earle R. Hedrick, professor of mathematics, University of California at Los Angeles.
Section B (Physics), Dr. Bergen Davis, professor of physics, Columbia University.
Section C (Chemistry), Dr. C. A. Browne, chief of the Bureau of Chemistry, U. S. Department of Agriculture.
Section D (Astronomy), Dr. J. H. Moore, astronomer, Lick Observatory.

Section E (Geology and Geography), Dr. Douglas Johnson, professor of physiography, Columbia University.

Section F (Zoological Sciences), Dr. Robert Hegner, professor of protozoology, The Johns Hopkins University.

Section G (Botanical Sciences), Dr. Elmer D. Merrill, director, New York Botanical Garden.

Section H (Anthropology), Dr. William K. Gregory, curator of paleontology, American Museum of Natural History, and professor of paleontology, Columbia University.

Section I (Psychology), Dr. Herbert S. Langfeld, professor of psychology, Princeton University.

Section K (Social and Economic Sciences), Dr. Griffith C. Evans, professor of mathematics, Rice Institute.

Section L (Historical and Philological Sciences), Dr. W. B. Munro, professor of history and government, Harvard University, and the California Institute of Technology.

Section M (Engineering), Dr. Dexter S. Kimball, professor of engineering and dean of the College of Engineering, Cornell University.

Section N (Medical Sciences), Professor Howard T. Karsner, professor of pathology, Western Reserve University.

Section O (Agriculture), C. G. Williams, Ohio Agricultural Experiment Station.

Section Q (Education), Professor Ernest Horn, professor of education, State University of Iowa.

Other elections were as follows:

Council members to succeed Dr. L. E. Dickson, University of Chicago, and Dr. David White, of the U. S. Geological Survey, are Dr. F. G. Cottrell, U. S. Department of Agriculture, and Dr. A. F. Woods, U. S. Department of Agriculture.

Members of executive committee to succeed themselves: Dr. J. McKeen Cattell, Garrison, New York, and Professor Henry B. Ward, University of Illinois.

Members of the committee on grants for research to succeed Professor W. Lash Miller, of the University of Toronto, and Professor Oswald Veblen, of Princeton University, are Professor S. C. Lind (chemistry), of the University of Minnesota, and Professor Carl E. Guthe (anthropology), of the University of Michigan.

Member of the finance committee, Herbert A. Gill to succeed himself.

Nomination for board of trustees for Science Service, J. McKeen Cattell to succeed himself.

Secretary of the academy conference, Dr. S. W. Bilsing, of the Texas Agricultural and Mechanical College.

Secretary of the secretaries' conference, Commander N. H. Heck, secretary of Section M.

SCIENTIFIC NOTES AND NEWS

DR. J. PERRIN SMITH, emeritus professor of paleontology at Stanford University, with which he had been connected since 1892, died on January 1. He was sixty-six years old.

IN the British New Year's list of honors Sir Ernest Rutherford, professor of experimental physics and director of the Cavendish Laboratory at the University of Cambridge, has been made a baron; Sir John Rose Bradford, president of the Royal College of Physicians, and Sir Richard Gregory, editor of *Nature*, have been advanced to be baronets; Frank E. Smith, director of scientific research at the admiralty and secretary of the Royal Society, has been knighted.

THE one thousand dollar award of the American Association for the Advancement of Science for an outstanding paper presented at the Cleveland meeting was given to Drs. M. A. Tuve, L. R. Hafstad and O. Dahl, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Their paper entitled "Experiments with High Voltage Tubes" was presented to the American Physical Society.

DR. J. HOWARD BROWN, professor of bacteriology in the School of Medicine of the Johns Hopkins University, was elected president of the Society of American Bacteriologists at the recent meeting at Boston. Dr. L. A. Rogers, of the U. S. Department of Agriculture, and Dr. Norman MacL. Harris, health commissioner of Ottawa, Canada, were elected members of the council. The society will hold its next meeting at the Johns Hopkins Medical School. In 1932 it is planned to meet at the University of Michigan.

DR. ALFRED C. LANE, Pearson professor of geology and mineralogy at Tufts College, was elected president of the Geological Society of America at the forty-third annual meeting held in Toronto.

DR. W. F. G. SWANN, director of the Bartol Research Foundation of the Franklin Institute, was elected president of the American Physical Society at the Cleveland meeting.

DR. FRANCIS CARTER WOOD, of the Crocker Cancer Research Institute of Columbia University, is president-elect of the Radiological Society of North America.

PROFESSOR WILLIAM KING GREGORY was elected president of the Galton Society and Mr. Frederick Osborn secretary-treasurer at the meeting of the society on December 15.

DR. W. D. LAMBERT, of the U. S. Coast and Geodetic Survey, delivered on January 3 the address as retiring president of the Philosophical Society of

Washington. His subject was "The Variation of Latitude."

Dr. David White, senior geologist of the U. S. Geological Survey and home secretary of the National Academy of Sciences, was awarded the Penrose Medal at the Toronto meeting of the Society of Economic Geologists.

Dr. Julius F. Riedenwald, of Baltimore, has been awarded the Phi Lambda Kappa medal bestowed annually upon the Jewish physician who has contributed most to the science of medicine.

Dr. F. L. Dunlap, consulting chemist, of Chicago, has been elected a foreign member of the Masaryk Academy of Czechoslovakia.

Raymond G. Bressler, deputy secretary of agriculture of Pennsylvania, formerly professor at Texas Agricultural and Mechanical College and vice-dean at Pennsylvania State College, has been elected president of Rhode Island State College. He succeeds Dr. Howard Edwards, who died April 9, 1930. Dr. Bressler will take up his work as president on April 1.

Dr. F. E. Breithut has been made professor of chemistry and head of the department of chemistry of the Brooklyn College of the College of the City of New York.

Dr. Forrest D. McCrea, of Cleveland, has been appointed professor of physiology and pharmacology at Duke University School of Medicine.

Dr. O. E. Kiessling has been appointed chief economist of the mineral statistics division, and Mr. W. W. Adams chief statistician of the newly created demographical division in the U. S. Bureau of Mines. Dr. Kiessling succeeds the late Frank J. Katz, who had served as chief economist of the mineral statistics division economic branch for many years.

Mr. Sidney Smith, assistant keeper in the department of Egyptian and Assyrian antiquities at the British Museum, has been appointed keeper of the department in succession to the late Dr. H. R. Hall.

Dr. Karl Landsteiner, of the Rockefeller Institute for Medical Research, reached New York on January 3 after a visit to Stockholm, where he went to receive the Nobel prize in medicine.

Professor Parke Hardy Struthers, head of the Syracuse-Andean Expedition for the study of rare birds, animals and reptiles, with ten collaborators sailed on December 31 on the way to the Sierra Nevada range of the Andes. The party will disembark at Porto Cabello, Venezuela, where they will be joined by natives and proceed inland more than 500 miles to the jungles of Meridia where the expedition will establish its headquarters. Others in the group include Dr. Robert Crockett, bacteriologist; Dr. Ernest Reed, botanist; Dr. Earl T. Apfel, geologist; Professor Sidman Poole, geographer; Wesley Curran, assistant zoologist, and Philip Barnes, photographer. The expedition is to last six months.

Dr. R. A. Millikan, of the California Institute of Technology, delivered a lecture on December 20 before the Royal Canadian Institute on "The Cosmic Rays in Canada."

Dr. F. K. Richtmyer, of Cornell University, gave a popular talk on "X-rays and Their Uses" on November 11 at St. Lawrence University, Canton, New York, under the auspices of the St. Lawrence (Iota) chapter of Sigma Pi Sigma, national honorary physics fraternity.

Captain Donald B. MacMillan, the explorer, will give three lectures accompanied by motion pictures at the University of California on January 15 and 16. The subjects are "Iceland" and "Northern Lights."

Sir Arthur Eddington formally opened on January 6 the twenty-first annual exhibition of the British Physical and Optical Societies at South Kensington. Two lectures with experiments were given on January 7 and 8 by Mr. E. Lancaster-Jones on "Searching for Minerals with Scientific Instruments," and by Sir Gilbert Walker on "Physics of Sport."

At a meeting of the Galton Society on December 15, Professor G. Elliot Smith, of University College, London, addressed the society on the Peking Man (*Sinanthropus*). Professor Elliot Smith spoke on the same subject before the College of Physicians of Philadelphia on December 11.

The Second International Congress of Comparative Pathology will meet in Paris, from October 14 to 18. The secretary of the American committee is Dr. George W. McCoy, National Institute of Health, Washington, D. C.

By the will of the late Rossiter Betts, the residue of his estate amounting to about $1,000,000 is left to Yale University. Legacies of $5,000 each were made to the New York Institute for the Deaf and Dumb, of which the testator was president; the New York Zoological Society, the New York Botanical Garden, the Metropolitan Museum of Art and the American Museum of Natural History. The Hampton Normal and Agricultural Institute at Hampton, Virginia, and the Berry School at Mount Berry, Georgia, receive $2,500 each for scholarships.

Mrs. D. A. Dunlap, as a memorial to her son, has

provided funds for a new astronomical observatory for the University of Toronto to be known as the David Dunlap Observatory. The 24-inch reflecting telescope is already under construction in England, and will be housed in a circular metal building to be erected near the city on a large acreage which will be converted into a park. The observatory will be in charge of the department of astronomy of the University of Toronto, while the faculty of forestry will be in charge of development of the park.

MR. GEORGE EASTMAN, of Rochester, New York, is reported to have given $1,000,000 to the city of Stockholm, Sweden, for a dental dispensary similar to the Rochester Dental Dispensary and to those recently established by Mr. Eastman in London and Rome. The Stockholm clinic will include one feature not provided for in the other foreign cities, a school for dental hygienists similar to that of the Rochester dispensary.

BATTELLE MEMORIAL INSTITUTE at Columbus, Ohio, announces the establishment at the institute of a research project sponsored by the Ohio Steel Foundry Company of Lima and Springfield, Ohio. This will consist of a comprehensive study of steel-foundry practice with a view to developing improvements and economies in practice as well as the betterment of finished products. Dr. C. H. Lorig, a member of the staff and a specialist in foundry practice, will be in immediate charge of this work under the direction of Mr. Clyde E. Williams, assistant director.

FOUR Mississippi State educational institutions were dropped from the eligible list of the American Association of University Professors at the annual meeting at Cleveland. The association voted to condemn wholesale dismissals of faculty members by Governor Theodore G. Bilbo last June and July. The resolution said that "much damage has been done to the cause of education in Mississippi as well as a great injustice to those dismissed or demoted." It charged the 179 dismissals and demotions were made "apparently for political reasons, without due consideration of the welfare of the students affected, and, so far as we are informed, with no notice to those dismissed or demoted." The schools placed on the ineligible list "until such time as the administration of educational affairs in the State of Mississippi has been restored to a status acceptable to this association" are: University of Mississippi, the Agricultural and Mechanical College of Mississippi, the Mississippi State College for Women, and the State Teachers College. This action, effective immediately, means that members can not teach at the institutions and retain their association membership. It was explained that credits of students are not involved, but have been jeopardized by the action of the Southern Association of Colleges and Secondary Schools. The association also adopted a "statement of principle" declaring that "no university professor who receives a fee from any person or association interested in public discussion or in testimony respecting a particular question of public importance should take part in such discussion without making public the fact that he receives such compensation and making public the name of the person or association paying him the said compensation."

THE Czechoslovak Ministry of Education has created a radio section which will have charge of the installation of radios in Czechoslovak schools and the broadcasting of school programs. Special school programs will be broadcast twice daily, according to preliminary plans. Radio sets will be installed in 13,000 primary schools at a cost of approximately 60,000,000 crowns, or about $1,800,000. The larger schools will include the cost of installing radio equipment in their current budgets while arrangements will be made for the smaller schools to receive credit and pay for the equipment over a period of several years.

THE *Journal* of the American Medical Association reports that the erection of the new Institute of Public Health in Rome, in the vicinity of the Policlinico, by the Italian government, toward which the Rockefeller Foundation made a large contribution, was recently begun. The institute will be under the direct control of the public health service and will have functions entirely distinct from those of the university institutes of hygiene. Its chief purpose will be the creation of a school for the education and training of sanitary personnel; it will serve as an aid to the public health service in the country in general, in the provinces and in the communes. The present laboratories of the public health service and of the school for the study of malaria will be reorganized, with new equipment, and will be located in the new institute.

THE Forest Service recently sent congratulations to the Forest School at Eberswalde, Germany, on the school's one-hundredth anniversary. These congratulations are in the form of an illuminated parchment with gold-colored hand-drawn letters and design bearing the message: "The Forest Service of the United States Department of Agriculture congratulates Forstliche Hochschule, Eberswalde, Germany, upon the occasion of its one-hundredth anniversary."

ACTING upon the recommendation of Secretary of the Interior Wilbur, President Hoover by proclamation, dated November 14, added approximately 11,010 acres of land to the Petrified Forest National Monument, Arizona. With this addition the total area of

the monument now is 36,918 acres. The new area contains many features of scientific interest which will be easily accessible to visitors upon the completion of the bridge which the National Park Service plans to build across the Rio Puerco. This bridge is necessary for the convenience of visitors to the Petrified Forest and the new addition contains the most feasible site for its construction. In the past, flood conditions in the river have frequently made impassable the road leading into the forest. The age of the petrified trees, whose fragments cover the ground over an area of over 100 square miles, of which more than half is included in the monument, is estimated at 200,000,000 years. None of the trees is standing. The petrified trunks, more or less fractured, dismembered, and lacking branches, all lie prostrate on or in the ground. Where a trunk or stump is found in an upright position, it is due to tilting of the already petrified log by natural forces. The ancient living forests which supplied these logs did not grow in the location in which they now are found. When the trees fell or were knocked over, they drifted down some prehistoric stream, became waterlogged and sank. Sand and pebbles gathered around and over them and finally thousands of feet of sandstone settled upon them. Changes then took place in the trees, turning them from wooden trunks into a mass of agate and carnelian, still in the shape of the original trees. Then, as the ages went on, there was a slow upheaval of the land, and erosion finally exposed the now thoroughly petrified logs and the innumerable small fragments. In the Petrified Forest National Monument there are three principal forests. Although they are the same geologically, erosion has produced different results in the three areas, and the color and texture of the "wood" also varies considerably.

INVENTIONS made in carrying on research work in the Engineering Experiment Station at the Ohio State University may, at the discretion of the trustees of the institution, be patented either for the benefit of the university or for the benefit of an individual, firm or corporation for which the research work was done, according to a ruling of the Attorney General, Gilbert Bettman, given in response to an inquiry from Dr. George W. Rightmire, president of the university. Persons with whom the university cooperates in experiments have not, by mere force of the relation of the parties, any exclusive rights under the law in inventions made possible as a result of such experiments, the attorney general held, even though such work is financed by funds contributed by them.

DISCUSSION

METEOR BUTTE

THE origin of the geologic formation in Arizona called Meteor Butte (formerly known as Coon Butte), near Sunset Station on the Atchison, Topeka and Santa Fé Railway, has long been considered something of a mystery, although in recent years it has positively been ascribed to the impact of a giant meteor—hence the change of name. The dimensions of the huge basin are: diameter about 4,000 feet, depth 570 feet: a truly remarkable hole in the ground.

In SCIENCE, November 7, 1930, Professor H. L. Fairchild expounds most learnedly his explanation of the origin by collision with a meteor as well as the reason why no vestige of the colliding mass is found either in the butte or anywhere near it.

Inasmuch as no evidence is discoverable of a meteoric body capable of excavating such a large basin, notwithstanding long, competent and diligent examination, and as my poor intelligence sees nothing reported that substantiates in the slightest degree the meteor theory, I venture to disbelieve that theory in toto.

For my part I have always been skeptical in the matter, but I have patiently waited for the drillings and investigations to turn up some credible evidence. No evidence has come that appears to me at all competent.

Mr. D. M. Ballinger, some years ago, caused numerous drillings to be made to considerable depths. He reported the results in an admirable paper read before the National Academy of Sciences in 1909; later printed. This paper he accompanied with a number of very clear diagrams and some excellent photographs of the "butte" taken both inside and outside the so-called crater.

All this drilling and investigating proved one thing *definitely:* that the underlying rock strata are in "continuous and undisturbed position." They also developed the fact that there exists copious ground water. This latter fact is to be specially noted with reference to what follows.

According to Professor Fairchild, whose competency in geology is unquestioned, the topmost continuous stratum is the Kaibab Permian limestone,

250 feet thick, with all the other regular beds below it in position.

Now the key to this problem—the origin of Meteor Butte—seems to me to rest, not in a mythical meteor, but in the presence near the surface of this Kaibab limestone.

It is well known that every rock formation possesses certain peculiarities—certain individual characteristics which we might call "personal" features. One exhibits cross-bedding; another has a tendency to choncoidal fracture and presents arches and natural bridges; still another yields towers, pinnacles, and so on. This is all too well known to require more than mention.

The peculiarity or "personal" quality of the Kaibab formation is that it has a sponge-like character. On the Kaibab Plateau, whence comes the name of this limestone, there are no brooks or streams flowing on the surface. Instead there are circular drainage basins without apparent inlet or outlet. These basins are of varying size and they are numerous. Their diameter and depth range from an almost imperceptible slope from circumference to center, to several hundred feet in diameter and a hundred feet or more in depth. Some hold water; some do not, most in fact do not.

These sinkholes appear to be the individual feature of the Kaibab limestone. On my first visit there, many years ago, they struck my attention immediately as being something unusual. Dutton was there about the same time and noted the sinkholes as something new.

The explanation seems simple. It is merely a broad downward drainage through porous rock. The Kaibab, of wide extent, is devoid of surface streams, even of the smallest rivulets, yet there is a considerable rainfall, while snow is deep, owing to an altitude of 8,500 feet. The water goes off, of course, but it goes *down* all over the plateau forming these sinkholes.

Doubtless this feature occurs elsewhere but not so prominently as on the Kaibab Plateau. The dissolved rock and other débris is carried down and deposited below where the water reappears as it does in Havasu Canyon and along the breaks of the north wall of the Grand Canyon in the Kaibab Division.

These sinkholes of the Kaibab, some of them at least one fifth as large as Meteor Butte, being in the same limestone that forms the upper structure of Meteor Butte would seem to offer a perfectly reasonable explanation of the origin of Meteor Butte.

That is to say: *Meteor Butte is entirely the work of erosion* and no meteor has had anything to do with its formation. The interior cliffs of the circumference appear, from the photographs, to be cliffs of erosion, for they have every characteristic. The exterior slopes of the circumference appear to be slopes of erosion, for they have every characteristic. The down inside drainage undoubtedly is into the near-by Canyon Diablo.

Where there are local tiltings and dislocations as they occur in the circumference they are doubtless due to washing out of softer portions or some other well-understood freak of erosion.

Meteor Butte, then, seems to be merely the reverse of a solitary mesa which preserves itself by a hard roof against erosion. The Meteor Sink had a soft spot where its hat ought to have been.

FREDERICK S. DELLENBAUGH

NEW YORK, N. Y.

DIASTROPHISM AND DISCOURTESY

IN youthful days the writer regarded geologists as supermen, devotees of the most inclusive and inspiring of all the sciences. But membership in the guild, for lo, these many years, reveals that we are ordinary mortals, with the common frailties of human-kind.

In his address to Section E, American Association for the Advancement of Science, as reported in this journal of January 17, page 53, Dr. Frank Leverett stepped out of the path of his address to make an ungenerous and unjust personal reflection, as follows:

> In this connection attention is directed to an erroneous map prepared by a leading American glacialist, in which isobases of postglacial uplift are made to correspond to an estimated thickness of the ice-sheet in the region east of the Mississippi River, thus disregarding the results previously published of observations showing that there is no such correspondence. No progress can be made where office speculation is substituted for or given more weight than field studies.

A perusal of my description and discussion of the "erroneous map" (Bulletin of the Geological Society of America, 29, 1918, 201–205) will convince the reader that the implied discredit in "office speculation" is not justified. It would appear as if the speaker had merely looked at the map and neglected the accompanying explanation. Evidently he ignores it, and regards "previously published observations" as final and sacred.

The following excerpt from my paper (page 203) is only part of the tentative and suggestive matter which was, and is, wholly justified, as will be shown later.

> The map shows that the postglacial land uplift of northeastern America is fairly proportionate to the area and thickness of the latest ice-sheet, and it appears legitimate to suggest similar relation in the Mississippi

and Great Lakes region. The southward curve given to the lower-value isobases may be excessive, but they suggest an uplift for which evidence should be sought.

It should be understood, therefore, that the isobases as extended in the Mississippi Basin are intended to be only suggestive of the southerly limit of the Pleistocene land uplift, . . .[1]

The personal element may be dismissed, but the involved geologic problem merits brief discussion. The isobases of postglacial continental uplift in my map were based on careful field study, extended in both area and time; with included data from Canadian explorers. That the area of diastrophic movement, postglacial land uplift, closely coincided with the glaciated area, and that the amount of uplift, where clearly determined, was in close agreement with the supposed thickness of the ice-sheet was fact from observation and was not theory.

Because a tilting uplift is not registered in the glacial lake beaches in the southern ends of the Michigan and Erie basins, the assertion is made that there was an entire absence of uplift in the territory on south. But such assertion, with disdain for different opinion, is not proof. Lack of positive evidence is often inconclusive.

Along the border of the glaciated territory wherever water-planes existed to record land warping there was postglacial uplift to the extreme reach of the ice-sheet. This applies to all the area east of New Jersey.

With an exception to be noted below there were no extensive bodies of water over Illinois, Indiana and Ohio to register differential uplift. But with a thickness of several thousand feet of ice of the earlier ice invasions pressing down on that territory it seems highly improbable that it was not affected like lands under even thinner ice in the eastward areas.

Following the slow removal of the weight of ice, from south to northward, the rise of the land surface evidently by a wave-like uplift, progressing northward over the United States. The land rise about the periphery of the depressed area was earlier in time than northward toward the center of the ice load. Hence it should be expected that the southern ice-covered area in the Mississippi Basin would be upraised before the area of the Great Lakes. And such rise was either previous to or during the life of the glacial lakes Chicago, Maumee and Whittlesey. For that southern district the rise was "postglacial," but in what was yet "glacial time" for the northern lands.

[1] This map was republished in SCIENCE, Vol. 47, 1918, page 166. It carries one serious error. Newfoundland is represented as an area of uplift distinct from that of North America. The contributed information on which that mapping was based was later found erroneous.

However, we do have a bit of positive evidence of postglacial land warping in the southern area. In 1914 Professor George D. Hubbard described the tilted shorelines of an extinct lake in Alaska and Wayne counties, in north-central Ohio.[2]

This "Craighton Lake" was eighteen miles long, and the differential uplift of the shorelines was determined as about four feet per mile. This study has been adversely criticized because it was unexpected and contrary to theory.

In the same address (page 53), after assuming the absence of uplift south of the Michigan and Erie basins, although granting a thickness of thousands of feet of ice, Leverett makes the following statement:

> These studies and studies in other basins occupied by glacial lakes have shown that the uplift extends only a short distance beyond the Precambrian lands into the lands covered by Paleozoic formations. There appears to be a closer correspondence with the border of the Precambrian lands than with the amount of ice weighting. It appears that the ice weight was insufficient to cause such a depression in the stable areas covered with sedimentary Paleozoic formations as it was able to produce in the highly eroded Precambrian areas.

Every text-book of geology will show the main Precambrian area lying north of the Great Lakes and the Ontario-St. Lawrence valley. Southward, the Precambrian patches are the core of the Adirondacks, the Hudson Highlands and a portion of New England. But all the Great Lakes area and all the continent east of the Hudson Valley has participated in the postglacial uplift. From north of Lake Ontario to New York City and from north of the St. Lawrence to the coast of Nova Scotia is not "a short distance" into the sedimentary formations.

The central area of postglacial uplift is not in the midst of the great Precambrian mass, but lies near the south border of that mass, southeast of James Bay, between that bay and Quebec City.

This center of the dome-shaped land uplift is presumably the area of the greatest depression under the ice-weighting. And evidently the latter was in consequence of the greater thickness of the ice. The central area of the postglacial uplift quite certainly locates the center of the Quebec (Laboradorian) ice cap, its feeding ground or "alimentation area." And such location was not affected by the nature and age of the underlying rocks, but was determined by the snow supply, which in turn was dependent on altitude and the atmospheric circulation.

The postglacial land uplift everywhere, as far as it has been clearly measured, appears to have direct relation to the thickness and weight of the ice load,

[2] *Amer. Jour. Science*, 37, 1914, 444–450.

It has no apparent relation to the character of the underlying rocks, nor to the land relief or the gross topography. And why should it? The cause of the up and down (diastrophic) movement of the land surface can be only slightly due to the elastic compression and expansion of the rocks. It is regarded as chiefly due to yielding and rock-flowage in the deep-down zone of plasticity. And this is very far below the base of any sedimentary rock.

Another interesting fact is that the isobases, or lines of equal uplift, pay no apparent respect to the great topographic features, as the deep and wide embayment of the St. Lawrence and the masses of the Adirondacks and White Mountains. And, again, why should they? These great features were produced far back in Tertiary time, and isostatic equilibrium had been long established, for both the nature of the rocks and the surface relief, before the Glacial Period. The ice caps were freshly imposed loads, with independent effect.

H. L. FAIRCHILD

THE CLASSIFICATION OF PYTHIUM

THE writer has read with some interest a note in a recent number of SCIENCE by C. P. Sideris entitled "The Proper Taxonomic Classification of Certain Pythiacious Organisms,"[1] as he has been investigating for some years those members of *Pythium* which possess filamentous sporangia, placed by Butler[2] in the subgenus *Aphragmium,* and has had an opportunity to examine minutely most of the newer species and nearly all the older ones.

It should be borne in mind that the genus *Pythium* was founded in 1858 by Pringsheim[3] on what must be regarded as a form possessing entirely filamentous sporangia (the term "sporangium" will be used here in its older sense without entering into the grounds for the distinction of pro- or pre-sporangium used by some more recent writers). Two years later de Bary[4] published his description of *P. proliferum,* a form in which the sporangium consisted of a spherical portion and a more or less elongated beak, the former structure being delimited from the rest of the hypha by a cross wall.

With the describing of *P. debaryanum* by Hesse,[5] in 1874, and de Bary's subsequent work on this species, *Pythium* became of peculiar interest to the pathologist because of the destructiveness of this species to the seedlings of various plants of economic importance. Since then, the pathological literature has contained many references to various types of diseases ascribed to *P. debaryanum,* and through it the genus has been, one might say, widely advertised.

In recent years it has become increasingly apparent that, aside from the two sporangial types heretofore described, there is a third one. Briefly, this consists of a basal portion of more or less compacted, swollen, digitate elements, separated as a whole by cross walls from the concomitant hyphae, and a filamentous evacuation tube through which the protoplasm of the two portions is discharged into a vesicle in the usual manner. This type is represented by such forms as *P. complens* Fischer, *P. aphanidermatum* (Eds.) Fitz. and others.

Fischer[6] in 1892, divided the species of *Pythium* then known into three subgenera. In *Aphragmium* he placed those forms which possess filamentous sporangia not differing from the vegetative hyphae and not cut off from these structures by cross walls. In *Nematosporangium,* he placed those forms with filamentous sporangia which did not differ from the vegetative hyphae, but were separated from them by septa. The species possessing subspherical to spherical sporangia he put in the subgenus *Sphaerosporangium.*

In 1897, Schröter[7] raised *Nematosporangium* to generic rank with two subgenera, *Aphragmium* and *Eunematosporangium.* Butler[8] proposed to retain the two subgenera of Fischer, but merged *Nematosporangium* with *Aphragmium.*

To any one who has studied the non-sexual reproduction of any of these filamentous types, it is apparent that cross walls must be laid down somewhere in the mycelium which will limit the flow of protoplasm, otherwise the whole content of the mycelium would be discharged at one time into the vesicle. In the hundreds of examples of such reproductive activity observed by the writer among various species which possess entirely filamentous sporangia, delimiting cross walls have always been observed.

These preliminary considerations lead to Mr. Sideris's suggested treatment of the genus.

Aside from the fact that he does not separate the entirely filamentous sporangial forms, such as *P. dictyosporum* Racib., *P. afertile* Kanouse and Hum-

[1] C. P. Sideris, "The Proper Taxonomic Classification of Certain Pythiacious Organisms," SCIENCE, 71: 323–324, March 21, 1930.

[2] E. J. Butler, "An Account of the Genus Pythium and Some Chytridiaceae," Mem. Dept. Agr. India, Bot. Series 1: 5, 162 pp., illus., 1907.

[3] N. Pringsheim, "Beitrage zur Morphologie und Systematik der Algen II," *Pringsheim's Jahrb. für wiss. Botanik,* 1: 284–306, 1858.

[4] A. de Bary, "Einige neue Saprolegnieen," *Pringsheim's Jahrb. für wiss. Botanik,* 2: 169–192, 1860.

[5] R. Hesse, "Pythium debaryanum, ein endophytischer Schmarotzer, etc.," Inaugr. Diss. Halle, 1874.

[6] A. Fischer, "Phycomycetes," in Rabenhorst's "Kryptogamenflora von Deutschland, etc.," 4: 391–410, 1892.

[7] J. Schröter, "Fungi," in Engler and Prantl's, "Die natürlichen Pflanzenfamilien," I[1]: 104, 1897.

[8] E. J. Butler, *loc. cit.*

phrey, etc., from those herein termed "lobulate" types, as represented by *P. aphanidermatum*, *P. arrhenomanes* Drechsler, etc., he applies the name *Pythium*, not to those entirely filamentous forms on which the genus was founded, but to those with spherical sporangia. In the amended form, as proposed by Sideris, *Nematosporangium* groups together species having two different types of sporangia, *i.e.*, the entirely filamentous and the lobulate ones. *Nematosporangium*, in the sense of Fischer and Schröter, fits well those forms placed in *Aphragmium*, for, as has been pointed out, Aphragmium types are an impossibility. As the name *Pythium* already exists for these forms, and, in fact, was first applied to the very species placed by Schröter in his genus *Nematosporangium* (*P. monospermum*), the latter generic name is superfluous.

The situation might be somewhat clarified if the lobulate types were placed in the genus *Rheosporangium*, the first generic name proposed for these forms (Edson).[9] While some slight changes would have to be made in defining the genus, it seems better to adopt it than to continue, in a greatly amended condition, an untenable and confusing one. This action would leave Pythium in its original sense applying to those forms possessing entirely filamentous sporangia. As to the disposition of the subspherical and spherical sporangial forms, the writer does not feel so competent to express an opinion. Several courses, however, seem open: to raise the subgenus *Sphaerosporangium* to generic rank; to merge the group with *Phytophthora*, established by de Bary in 1876, or to revive one of the several generic names proposed in the past for various members of this group. If the genus *Pythium*, in the inclusive sense of Butler, is to be broken up into several genera, as seems entirely feasible, the name *Pythium* should apply only to those entirely filamentous sporangial types on which the genus was founded and not to those forms with spherical sporangia.

The salient features by which the three genera may be separated from each other are as follows.

Pythium: Zoosporangium identical with the filamentous vegetative hyphae, consisting of a hyphal segment delimited by cross walls; the content being discharged through a hyphal branch into a vesicle formed at the apex of this structure; not proliferating; the discharged protoplasm entirely delimited into zoospores within the vesicle.

Rheosporangium: Zoosporangium consisting of a subspherical portion or a series of more or less compacted, intercommunicating, lobulate elements cut off from the vegetative hyphae by septa, and a filamentous evacuation tube which arises from the basal portion and through which the content of the whole complex is discharged into the vesicle; not proliferating; the discharged protoplasm entirely delimited into zoospores within the vesicle.

Phytophthora or *Sphaerosporangium* n. gen.: Zoosporangium narrowly ovoid, spherical or citriform, clearly distinguishable from the vegetative hyphae from which it arises and is separated by a cross wall; renewed by proliferation or branching of various types; vesicle present or absent; zoospores sometimes clearly delimited within the sporangium and emerging fully formed.

F. K. SPARROW, JR.

DARTMOUTH COLLEGE

[9] H. A. Edson, "Rheosporangium Aphanidermatus, A New Genus and Species of Fungus Parasitic on Sugar Beets and Radishes," *Journ. Agr. Res.*, 4: 279–291, 1915.

TWO NEW DOMINICAN FORMATIONAL NAMES

THE MARINE PLIOCENE GATO FORMATION

THE later Señor Rodolfo Cambiarso, a resident of Santo Domingo City, presented me, in 1916, with a very fine fossil sea urchin that he had collected at Gato, Provincia del Seibo, on Rio Chavon, northeast of the port of La Romana, Dominican Republic. This town is shown upon the Santo Domingo-San Juan folio map of the American Geographical Society of New York. I gave the specimen to the U. S. National Museum, and Dr. R. T. Jackson identified it as *Clypeaster dalli* Twitchell,[1] and later described it in his "Fossil Echini of the West Indies,"[2] leaving the age indeterminate, Miocene or Pliocene.

This very handsome Dominican specimen is the only example of the species ever recorded except the type which Twitchell[3] described from near Fort Thompson, Caloosahatchee River, in the Caloosahatchee Pliocene of Florida.

In 1929, I referred my Gato beds to the marine Pliocene.[4] No other marine Pliocene has been differentiated in the Dominican Republic. I now propose for this interesting horizon, characterized by *Clypeaster dalli* Twitchell, the name Gato Formation.

The Gato formation of the Dominican Republic was laid down about the same time as the marine Pliocene beds described by Drs. Woodring and Brown[5]

[1] C. J. Maury, *Bull. American Paleontology*, No. 30, pp. 20–21, 1917.

[2] R. T. Jackson, Carnegie Inst. Washington, Publ. No. 306, p. 37, 1922.

[3] Clark and Twitchell, Monograph U. S. Geol. Surv., Vol. 54, p. 218, Pl. 99, Figs. 2a-b; Pl. 100, Figs. 8a-b, 1915.

[4] C. J. Maury, SCIENCE, p. 609, December, 1929.

[5] Woodring and Brown, "Geology of Haiti," pp. 241–242, 1924.

on Rivière Gauche, arrondissement of Jacmel, Republic of Haiti.

THE UPPER MIOCENE CAIMITO FORMATION

The lithological and faunal characters of the beds at Caimito, on Rio Cana, in the valley of Rio Yaque del Norte, Dominican Republic, were described by the writer[6] in 1917. The beds were found by the Maury Expedition, and the horizon was seen to be very intriguing, and an Upper Miocene age was suspected.

Later, from researches of the Vaughan Expedition, the Cerro de Sal formation, on the southern side of the Dominican Republic, in the Province of Barabona, near Las Salinas and Angostura, was described by Messrs. Condit and Ross[7] and referred to the Upper Miocene.

In 1929, I definitely referred the Caimito beds to the Upper Miocene,[8] and now propose for this horizon the name Caimito Formation.

CORRELATION OF UPPER MIOCENE ANTILLEAN HORIZONS

The following correlation of the Upper Miocene beds of the West Indies is now suggested. Those of Trinidad Island were discussed in detail by the writer in 1925.[9]

Upper Miocene: Younger or Caimitoan stage, Dominican Republic, north side, Caimito formation; south side, Cerro de Sal formation, apparently slightly younger than the Caimito. Trinidad, west central part of the island, Gomez Estate beds and Freeport to Todd's road outcrops. Tobago Island, Botanic Station beds. *Upper Miocene: Older or Springvalean stage,* Trinidad, Savanetta and Springvale beds near Couva, in the western part of the island; Pointe Noir beds on the eastern side of the island.

Climate of the Caimitoan Stage: Gypsum in the form of encrustations, plates and crystals is present in the Caimito formation. It is also abundant in the Cerro de Sal formation where it is followed by salt, which runs about 90 per cent. sodium chloride. This indicates aridity and excessive evaporation towards the close of the Upper Miocene. Conditions recall the gypsiferous strata of the Catahoula formation, regarded by the writer as equivalent to the Tampa formation of the Lower Miocene. The Cerro de Sal horizon is probably somewhat younger than the Caimito because the degree of evaporation exceeded that required for the precipitation of gypsum, and the beds of nearly pure salt were deposited.

Salt marsh and shallow lagoonary habitats are indicated for the faunas of the Caimitoan stage, concomitant with a rising coast-line and withdrawal of the sea off shore.

CARLOTTA J. MAURY

YONKERS, N. Y.

[6] C. J. Maury, *Bull. American Paleontology,* No. 30, pp. 25–26, 1917.

[7] "Geol. Reconnaissance Dominican Republic," pp. 214–215, 1921.

[8] SCIENCE, p. 609, December, 1929.

[9] *Bull. American Paleontology,* No. 42, 1925.

REPORTS

INVESTIGATIONS IN PANAMA DURING THE SUMMER OF 1930[1]

INTRODUCTION

AT the suggestion and on the invitation of Dr. Herbert C. Clark, director of the Gorgas Memorial Laboratory, Panama City, the writer undertook the investigation which is presented in this report. Facilities were extended so that Dr. William H. Martinez, a Tulane Medical School graduate, accompanied the writer, and later Mr. Alberto Prieto, a Tulane Medical School student resident in Panama, was enlisted as a technical assistant. In addition, non-professional personnel were secured locally in Panama City. The entire facilities of the Gorgas Memorial Laboratory and the connections which it enjoys in the Republic of Panama and the Canal Zone were placed at the writer's disposal for the work in view.

OBJECTS OF THE STUDY

The investigations were undertaken with the following objects in view.

(1) To study representative samplings of the population of Panama, in order to determine by present refined methods of examination the incidence of *Endamoeba histolytica,* both in its active and carrier states, and to discover, if possible, the public health importance of this infection in Panama at the present time.

(2) To study concurrently the incidence and significance of the following infections: giardiiasis, ascariasis, hookworm infection, trichocephaliasis and strongyloidiasis.

(3) To obtain autopsy confirmation of as many of these cases as was possible.

(4) To treat selected cases of *Endamoeba histo-*

[1] Contribution from the Gorgas Memorial Laboratory, Panama, and from the Department of Tropical Medicine, Tulane University.

lytica with di-hydranol; to treat hookworm infection, where it seemed advisable, with tetrachlorethylene, and to treat cases of strongyloides infection with gentian violet.

(5) To determine whether *Endamoeba histolytica* is a natural infection in New World monkeys in the wild state or whether their infection, if present, is acquired from contamination with human habitations.

MATERIAL STUDIED

During the three months which were available for this investigation the following series of cases were examined.

(1) The Hospital Santo Tomas of the Republic of Panama: medical wards, 635; surgical wards, 166; maternity wards, 445; total, 1,246.

(2) Canal Zone Administrative Office employees and families (white population only), 143. Gorgas Hospital patients and staff (white population only), 153. (This group represents individuals enjoying the best sanitated condition of the Canal Zone).

(3) Four Chagres River villages, 542.

(4) Tiura River villages (Darien Province), 105. These made a grand total of 2,089 cases. Of this number three or more fecal examinations were obtained on 1,340 individuals; two examinations on 326 individuals, and one examination only on 423. The total number of fecal examinations was in excess of 6,000, making an average examination quotient of approximately three per individual.

BRIEF RÉSUMÉ OF THE FINDINGS

(1) *Endamoeba histolytica.* (a) In the Santo Tomas Hospital, which represents the average cross section of the Panamanian population, the incidence of *Endamoeba histolytica* ranged from 12 to 18 per cent., the former being on medical wards and the latter on maternity services. (b) Canal Zone white administrative force employees, 2.81 per cent. (c) Gorgas Hospital patients and staff, 8.55 per cent. (d) Chagres River villages, 34 per cent. (e) Tiura River villages, 30 per cent. on one examination (children, 1 to 15 years, 38 per cent.; adults, 15 years or older, 18 per cent.). This last figure is based on one examination only, so that on a basis of three to six examinations the figure for children would range above 75 per cent. (f) Monkeys obtained in the wild state above the town of Boco de Cupe on the Tiura River, Darien Province, provided the following results: marmosets, negative for endamoebae; white-face monkeys, negative for endamoebae; black howling monkey, large numbers of active *E. histolytica, E. coli*, and *Endolimax nana*. In addition, autopsy examination of one red spider monkey, which had been in the animal house of the Gorgas Memorial Laboratory for several months, revealed a condition similar to that found in the black howling monkey. Likewise, a baby black howling monkey, which had been in the laboratory for less than one month, showed, on examination of passed feces, numerous cysts of *Endomaeba histolytica*.

Through the cordial cooperation of Dr. L. C. Prieto, of the maternity service of Santo Tomas Hospital, a considerable series of cases positive for *Endamoeba histolytica* received di-hydranol treatment. In every case the drug was effective in clearing up active or obscure symptoms involving the large bowel, and follow-up examinations showed that the dysentery amoebae had disappeared from the stools. A special paper will communicate these findings in detail.

Autopsies were obtained on five cases which had been previously diagnosed as harboring *Endamoeba histolytica.* Of this series two showed extensive deep chronic amoebic ulceration of the cecum, colon and rectum. The other three, which were carrier cases, showed no lesions which were detectable either by gross examination or by microscopic findings.

(2) *Giardia lamblia.* This infection ranged from 4½ to 9 per cent. in the Panamanian populations examined. It was more common in children than in adults.

(3) *Ascaris lumbricoides.* This worm was relatively common in the native populations, particularly in the country districts, but was fairly light as respects the number of worms in each case. As a filth infestation it was found to be more common in children than in adults.

(4) *Necator americanus.* This worm was also found to have a wide distribution but to be of relatively little clinical importance in the populations studied. It was not common among children under eleven years of age. Treatment with tetrachlorethylene on the maternity services of the Santo Tomas Hospital indicated the value of this drug in the treatment of such cases where toxic complications are to be avoided.

(5) *Trichocephalus trichiurus.* The infection with this worm ranged from seven tenths of one per cent. among the Canal Zone employees to 21 per cent. incidence in the Santo Tomas Hospital and rivertown populations. Most of these cases consisted of light infestations only, but from 15 to 20 per cent. constituted conditions of clinical significance. One case in particular, which was observed in the maternity service of the Santo Tomas Hospital, called for special consideration. This woman was almost *in extremis* at the time when observation was first begun. Her stools were watery in consistency and teemed with Strongyloides larvae. Treatment with gentian violet *per os* was instituted and improvement noted

after ten days, with larvae reduced to a minimum. By the end of three weeks her condition was markedly improved and the stools were formed. In less than five weeks she had left the hospital, having gained several pounds and with evidence pointing toward complete recovery.

Thirty-two heavy strains of Strongyloides were cultured and examined daily over a period covering approximately two and a half months. Five of these were duplicate strains from the same individuals. Of the total number, twenty-three strains showed direct development only, four showed indirect development only and five consisted of combined types. Clinical importance is attached to those direct strains which metamorphose into the filariform larvae without a previous feeding period. Larvae of this filariform type are frequently passed in stools of individuals showing clinical symptoms. Evidence is accumulating to indicate that this is the type which is responsible for hyperinfection of individuals.

Rare Parasites Encountered

Balantidium coli. This ciliate protozoon was encountered in four cases during the investigations. These cases gave a history of probable contamination from porcine sources. Red spider monkeys in the animal house also had this same infestation.

Hepaticola hepatica. This infection is common in rats and mice in various parts of the world but there is only one human case on record, from autopsy of a British soldier in India. Nine cases of this rare human infestation were diagnosed from the Chagres River Basin.

Gongylonema pulchrum. One case of this rare human infestation was diagnosed on the basis of eggs from the Chagres River Basin.

Examination of Animals in the Jungle of Darien Province

Altogether 45 animals were examined during the trip up the Tiura River in Darien Province. The majority of these were monkeys. Filarial infections were found in two types, the marmoset and the white faced monkeys. In the poncho (*Hydrochoerus hydrochoerus*) amphistomate flukes were obtained from the abdominal cavity. This is possibly the same fluke which was recovered by Dr. Clark from the wild hog in the Coto region of Panama in February, 1929. Other helminth and protozoa parasites were obtained from the agoutis, the ponchos and the monkeys.

Conclusions

The material obtained from these investigations has indicated to the writer that the area studied offers extremely valuable opportunities for helminthological and protozoological work. The data obtained will serve as the basis for several important papers which will be published in the near future.

ERNEST CARROLL FAUST

TULANE UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

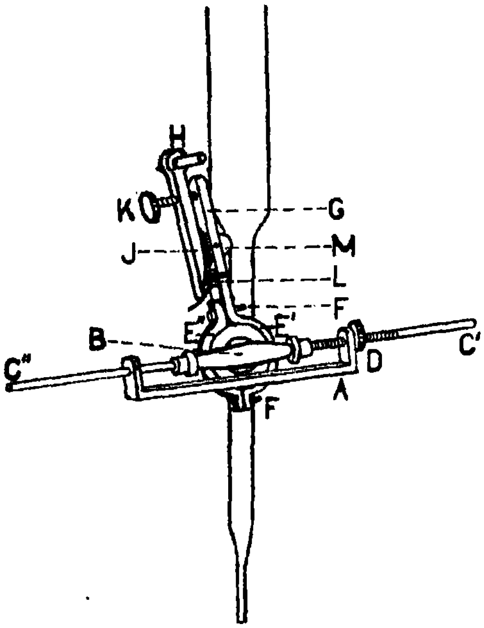
AN ADJUSTABLE DROP-CONTROL FOR BURETTES

FOR some time past, the writer has been performing micro-titrations to determine free and total acidities on one half to one cc of gastric juice. To insure an accuracy of better than one per cent., the burette employed was graduated so that one could estimate volumes to 0.002 cc. Since end-points were determined by comparison with colorimetric standards of definite pH, it was necessary to use drops of this order of magnitude in approaching the end-point. In order to obtain such drops, the burette tip was replaced by a Leuer adapter and a hypodermic needle (chromium plated or non-rusting steel) of such size as to give a freely falling drop of no more than 0.01 cc. Then, by opening the stopcock very slightly a small fraction of a drop was released, which could be taken off quantitatively with a stirring rod. However, the time and energy consumed by this procedure were so great as to cause an appreciable reduction in the efficiency of the worker engaged in these titrations. Therefore, a mechanical drop-control became imperative.

Such a device has been described by Müller[1] for use in potentiometric titrations where drops of uniform size are required. On attempting to employ his contrivance, two difficulties were encountered. Occasionally, the stopcock opened accidentally, due to a falling of the heavier end of the drop-control handle attached to the stopcock plug. Also, since it was necessary to add fractions of a freely falling drop, it was important that the rate of drop formation be readily controllable—which was not true in this case. Consequently, the requisite changes in the principle of Müller's device were made, and as the resulting instrument has proved very satisfactory for more than a year, it is described herewith.

It consists of two parts as indicated in the figure. The stationary part (EGJH), which carries the stop

[1] Erich Müller, "Elektrometrische (Potentiometrische) Massanalyse," 4th ed., 1926, p. 67.



(H), is attached to the sleeve of the stopcock; the movable handle (A), which strikes against the stop, is attached to the glass plug. Both parts are made of brass. To insure rigidity of the handle, the rod (C′) can be screwed tight against the handle of the plug (B) and can be clamped there by means of the nut (D).

The stationary part of the drop-control is clamped to the wider end of the glass sleeve by means of the semi-circular bands (E′ and E″), which are fastened together by two screws (F). One of these bands (E′) is an extension of the body (G); the other band is separate from it. The rod (H) serves as a stop to the rotating rod (C′ or C″) when it is desired to release a drop of reagent. This stop is set perpendicularly into the arm (J) which in turn is supported by (G). Support is effected by means of the projection (M) which passes through a hole in (G) and is held there by a pin, thus permitting a slight rotation of the arm (J) about the pin as fulcrum. The rotation is controlled by the screw (K) which passes through (J) and rests against (G). Movements of the arm, imparted by the screw, are opposed by the spring (L), which is held in a second hole in (G) by means of a pin. The free end of the spring is extended in such a way as to press against the lower end of (J).

The chief precaution to be taken in attaching the movable part to the plug is to have the glass handle fairly well centered with respect to (A). In attaching the stationary part, the body (G) is set at such an angle to the vertical that when the rod (C″) touches the stop (H), drops will flow from the burette tip at a slow but steady rate. Then, by means of the adjusting screw (K), the stop can be set at such a position as to permit the formation of freely falling drops at either a rapid rate or else so slowly as to enable the operator to remove small fractions of a drop at his convenience. On the other hand, it is always possible to get a steady flow of reagent from the burette by reversing the direction of rotation of (A) so that (C′–C″) is vertical. A strip of heavy rubber sheeting interposed between the semi-circular bands and the stopcock will prevent the latter from cracking.

The writer wishes to express his obligations to the departmental machinist, Willy Appledorn, for his assistance in constructing this instrument.

FRANKLIN HOLLANDER
DEPARTMENT OF PHYSIOLOGY,
N. Y. HOMEOPATHIC MEDICAL COLLEGE

SPECIAL ARTICLES

THE RELATIONSHIP BETWEEN ELECTRICAL DIFFERENCES OF POTENTIAL IN THE SKIN AND NORMAL BASAL METABOLISM

IN 1919 and 1920 Waller published the results of his researches on emotive phenomena and their correlation with variation of conductance of the palm of the hand. In general, Waller's experimental observations substantiated his view that there is "a close association between nutrition and what we may call emotion" and that there is reason for placing the "special class of emotive effects in the general category of trophic phenomena."[1] The experiments of Waller evidenced, therefore, a correlation between the electric resistance (or conductance) of the skin and nutritional changes and indicated that the emotive effect varied considerably in magnitude depending on whether the subject was rested or fatigued. No correlation between electrical conductance and general metabolic activity was attempted.

Waller was of the opinion that emotive effect is to be regarded as due to diminished resistance (increased conductance) rather than to increased electromotive force. However, Lund[2] and his colleagues

[1] A. D. Waller, "Concerning Emotive Phenomena. Part II. Periodic Variations of Conductance of the Palm of the Human Hand," *Proc. Roy. Soc. London*, Series B, 91: 17–31, 1920.

[2] E. J. Lund and W. A. Kenyon, "Relation between Continuous Bioelectric Currents and Cell Respiration. I.

very pertinently pointed out in the first of their series of articles on bioelectric currents and cell respiration that "methods which determine only the electromotive force and the changes in electromotive force are to be preferred when clearness of thought and interpretation and a greater nicety of distinction are to be attempted."

Lund concluded from his investigations on bioelectric currents and cell respiration that "the experiments definitely prove that the electric polarity of the cell is quantitatively correlated to the respiratory exchange of the cell and that electric currents accompany cell oxidation."[3] Lund[4] also advanced the theory that bioelectric currents produced by cells and tissues are the result of oxidation-reduction potentials developed by the respiratory mechanism of the cell, and that stimulation changes the electrical potential and therefore the electric polarity of the cell because it temporarily accelerates the reaction reductant → oxidant, thereby changing the ratio of oxidant to reductant. Data indicate the applicability of the familiar equation for oxidation-reduction potential

$$E = E_o - \frac{RT}{nF} \log \frac{[ox]}{[red]}$$

to the various phenomena studied.

Child[5] has written recently an excellent résumé of investigations on physiological gradients. Electrical potential differences are present along physiological axes (at least in many of the simpler organisms). In his consideration of differential susceptibility he pointed out that, in spite of criticisms, the data at hand show or indicate that differences in susceptibility to certain reagents are paralleled generally by quantitative metabolic differences. In general, "the protoplasmic factors immediately concerned in originating potential differences may be various, but that potential differences must be associated with the graded quantitative metabolic and other differences characteristic of the axial gradients appears to be beyond question."[6]

Electric Correlation Potentials in Growing Root Tips," *Jour. Expt. Zool.*, 48: 333–357, 1927.

[3] E. J. Lund, "Relation between Continuous Bioelectric Currents and Cell Respiration. V. The Quantitative Relation between E_p and Cell Oxidation as Shown by the Effects of Cyanide and Oxygen," *Jour. Expt. Zool.*, 51: 327–337, 1928.

[4] E. J. Lund, "Relation between Continuous Bioelectric Currents and Cell Respiration. II. A Theory of Continuous Bioelectric Currents and Electric Polarity of Cells," *Jour. Expt. Zool.*, 51: 265–290, 1928.

[5] C. M. Child, "The Physiological Gradients," *Protoplasma*, 5: 447–476, 1929.

[6] C. M. Child and L. H. Hyman, "Studies on the Axial Gradient in *Corymorpho palma*. I. Respiratory, Electric and Reconstitutional Gradients," *Biologia Generalis*, 2: 355–374, 1926.

Sheard and Johnson[7] have shown that, in response to various qualities and quantities of radiant energy, there is a definite correlation between the electrical potential differences developed across areas situated near the base and tip ends respectively of leaves intact with plants.

These experimental results and theoretical considerations as well as others not cited led us to investigations concerning the possibility of a relationship between differences of electrical potential in the skin and the basal metabolisms of persons who were said to be normal clinically.

We have used, with slight modifications, the nonpolarizable type of electrodes developed by Alvarez, Freelander and Clark.[8] Potential differences were measured by standard potentiometric methods or by a portable combination of apparatus consisting of a millivolter and a galvanometer. One of the nonpolarizable electrodes was placed on the skin of the forearm just above the articulation of the ulna and radius at the wrist; the second electrode was placed at an arbitrarily chosen but fixed distance of 12 cm. The distance of separation of the electrodes need not be very exact since a change of 1 cm in the position of one of the electrodes gives a negligible change in the potential difference between them. Furthermore, the difference of potential, due essentially to electromotive forces developed between two given areas on the skin at a given distance apart, is the same after any difference of potential between the electrodes *per se* have been taken into consideration. Such observations militate against the view that we are dealing with contact differences of potential.

We agree with the conclusions of Alvarez, Freelander and Clark that cleansing of the skin (as with water or alcohol) has little if any effect on the values of the potential differences obtained. It has been suggested that the presence or absence of perspiration would have an effect on the values of the potentials. In order to minimize such an effect, if present, we have applied the electrodes to the outer side of the forearm where the skin contains relatively few sweat glands. Waller believed that the emotive phenomena which he observed must be explained on a more comprehensive basis than that of sudomotor variation. It appears, therefore, that the condition of the surface of the skin where contacts are made with the electrodes is not of importance if the areas of contact are relatively small.

Readings on the difference of potential were made

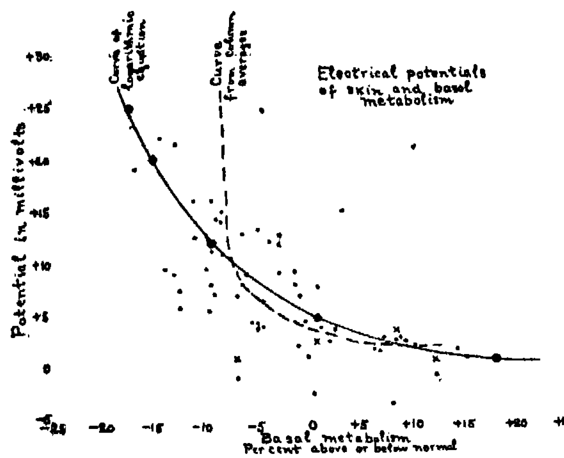
[7] Charles Sheard and A. Frances Johnson, "Potentiometric and Spectrophotometric Changes in Plants Produced by Infra-red and Ultra-violet Irradiation," *Proc. Soc. Expt. Biol. and Med.*, 26: 618–621, 1929.

[8] W. C. Alvarez, B. L. Freelander and L. B. Clark, "An Electrode for the Measurements of Skin Potentials," *Jour. Lab. and Clin. Med.*, 11: 83–85, 1925–26.

at various times during the period of rest of twenty minutes preceding the tests for the basal metabolism or again, in one group of subjects, during the metabolic tests. Basal metabolic rates were determined in certain groups with the Benedict-Roth closed circuit recording type of apparatus (measuring oxygen consumption) and in other groups by the open circuit gasometer followed by analyses of the expired air by the Haldane method. The Du Bois standards were used in our calculations.

The difference of potential between the electrodes applied to the skin ordinarily reached a fairly constant value after about ten minutes; if it did not, an average or a modal value was used. The true difference of potential then was obtained by subtracting the potential difference of the electrodes *per se* from the constant, average or modal value of the potential.

In Fig. 1 there are plotted the values of the potential differences as ordinates with the corresponding basal metabolisms, expressed in per cent. above or below normal, as abscissae in a group of persons presumably normal. The graph indicates a general tendency to grouping with some marked deviations. Treating the data statistically, a curve of the form



$$y = b\,e^{cx}$$

fits the data very well. With the insertion of the proper constants this equation becomes

$$x = \frac{\log\ y - \log\ 0.005}{-0.0396}$$

where x is the basal metabolism and y is the difference of electrical potential of the skin. The data of Fig. 1 show that higher basal metabolic rates are accompanied by lower differences of potential and *vice versa*.

Recently we have used the formula given in the preceding paragraph in an attempt to predict the basal metabolism. In a group of clinical subjects (some of whom had thyrogenous dysfunction) the predicted and observed values agreed within a range of ± 4 points in the metabolic rate expressed in percentage above or below normal in 62 per cent. of the individuals examined. The predicted basal metabolic rate agreed with the rate determined by test in nearly all cases (six exceptions) falling within the range of + 13 per cent. to − 10 per cent. Practically all the observed values which were not in agreement with predicted values fell either above + 13 per cent. or below − 10 per cent. The data as a whole, therefore, are divisible into three portions: (1) those showing a correlation between electrical differences of potential in the skin and basal metabolic rates such as are exhibited by normal individuals; (2) those above the normals, and (3) those below the normals.

It is known that individuals who have hypofunctioning thyroid glands manifest retardation in the rates of basal metabolism and circulation of the blood, whereas those who have excessive functioning of these glands show an increase in basal metabolic rates and in the circulation of the blood. We have carried out some experiments in which the circulation of the blood in the lower portion of the arm has been retarded or cut off by pressure and have observed marked increases of the differences of potential as compared to the values obtained under conditions of circulation of the blood ordinarily existing. Such observations indicate that there may not be a correlation of normal basal metabolic rates and differences of electrical potential of the skin if there are marked impairments of physiological functions, such as retarded (or accelerated) circulation, in the region in which the readings are made on the differences of potential. Since high and low basal metabolic rates (that is, outside the range of normal basal metabolism, + 10 per cent. to − 10 per cent.) are associated, respectively, in general, with a retarded or increased rate of circulation of the blood, it is entirely possible that the correlation lies between differences of electrical potential of the regions of the skin under test and circulatory conditions of the blood rather than between such potential differences and the basal metabolic rates *per se*. In normal, healthy individuals, however, with normal circulation of blood and normal physiological functioning of the skin there is a definite correlation between basal metabolism and differences of electrical potential.

The results of investigations now in progress regarding the electrical gradients in the skin and basal metabolism in various pathologic conditions as well as data concerning the general relationships existing between metabolic rates, skin temperatures, blood pressures, differences of electrical potential and so

SCIENCE

VOL. LXXIII — FRIDAY, JANUARY 16, 1931 — No. 1881

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. — Garrison, N. Y.
Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

ENGINEERING CULTURE[1]

By H. F. MOORE

RESEARCH PROFESSOR OF ENGINEERING MATERIALS, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

AT the outset of this paper it seems necessary that we should define what we mean by culture. The conventional thing to do is to quote an authoritative dictionary, but here we are met with difficulty. The word "culture" has seven or eight different definitions, varying all the way from "the details of a map which do not represent natural features of the area delineated," to the definition "refinement in manners and tastes." By some of our artist friends culture is regarded as measured by the production of works of art, while our friends the philosophers would doubtless insist that culture includes the formation of a philosophy of life. For the purposes of this paper we may perhaps regard culture as "the training, disciplining or refining of the moral and intellectual nature."

I wish to point out that taken in the sense of refinement of manners and morals, or in the artist's sense of production of works of art, a cultured man may be very narrow-minded. In Conan Doyle's novel "Sir Nigel," the young squire visits an old authority on the culture of knighthood, and the old knight is anxious above all else that this young friend always use exactly the correct word, lest he be the cause of laughter to his hearers and of grief to his friends. Especially must he recognize the fact that each species of animal has a distinctive name to designate a group. One must *never* speak of a *herd* of lions, but rather of a *pride* of lions. To speak of a *flock* of pheasants is a grievous sin against culture—it is a *nye* of pheasants. Similarly, to-day, there are many guardians of culture who are more shocked at a misspelled word (even in our quite unsystematic English spelling) than at a hazily expressed thought. Many there are who boast of themselves as liberals who are as deeply distressed as the strictest Pharisee at any infraction of any detail of the current social or literary

[1] Address of the vice-president and chairman of Section M—Engineering, American Association for the Advancement of Science, Cleveland, December 30, 1930.

code. If we limit the field of culture to literature, art and music we certainly are shutting out from any philosophy of life a consideration of many viewpoints which, be they good or evil, are certainly powerful to-day. In this paper I wish to maintain, first, that if we regard culture as the "training, disciplining, and refining of the moral and intellectual nature," we are not justified in excluding from any system of general culture a consideration of the viewpoint, either of the scientific *method*, or of the viewpoint of *applied* sicence. Why should we call uncultured the man who knows thoroughly and broadly the history and philosophy of the heat engine, but is ignorant of the music of Brahms, while we hail as cultured the musician who is a master of technique and knows the field of harmony, but is contemptuous of the applied science which has made possible the modern pipe organ.

The speaker wishes to make it very plain that he does not himself despise nor does he wish any engineer to despise the viewpoint of the philosopher, the artist, the writer, the musician, the student of literature, or the theologian. He does maintain, however, that no one of these, no, nor all of them put together, have the basis for a complete disciplining of the moral nature if they leave out of consideration the work and the methods of thought of the applied scientist. The author admires Plato, he reads his works (in translation) with interest, he is glad that Plato lived and that his work survived, but he does not believe that Plato is a complete guide for living and working.

It may be objected that the speaker has proposed so broad a field for culture that no man can thoroughly master it all. This is true. No man can master the whole field of art, of literature, of pure science or of applied science. He may, however, hope to master some part of one field and to be an interested and respectful observer of other fields. The jack of all trades and master of *none* is not an admirable figure. The speaker believes that the jack of all trades and the master of *one is* an admirable figure, and is more deserving of the title of cultured man than is the super-master of one trade who despises all others. The speaker believes that the narrow specialist, be his specialty music or hog breeding, poetry or heat engines, is frequently, especially at times of crisis, a most useful citizen, but that he does not embody a high degree of culture.

Accepting the idea that culture includes as a major object the development of a philosophy of life, the speaker believes that the engineer has some positive contribution to make to such a philosophy. Perhaps the positive contributions are not so great as the indirect, and this point will be discussed later.

One positive contribution toward a development of culture which the engineer is well fitted to make, or at least to emphasize, is the demand that the field of interest underlying such a philosophy be broadened to include not only the viewpoint of pure science but the application of that viewpoint to the affairs of daily life, and a consideration of the resultant effect upon our thinking. The speaker, so far from wishing to belittle the importance of the classical viewpoint of culture wishes to express his admiration—a rather uncritical admiration—of it, and his belief that all modern thinkers, including all engineers, might well become more familiar with the classical viewpoint. However, one characteristic attitude of that culture—the frank placing of the affairs of earning a livelihood in an *inferior* class—the writer believes to be a fault of that culture and not a virtue. An effect of that fault is plainly illustrated by the inability of the great minds of the classical world to develop the science of mechanics beyond a most elementary stage. It was not until an entirely new frame of mind came in, under Galileo—a frame of mind which in the search for knowledge, and in the development of the philosophy of life, "called nothing common or unclean"—that the science of mechanics, the first ripening fruit of the scientific age, was able to develop.

The essentially aristocratic attitude of superiority to those who have to work for a living is not necessarily snobbish, but it easily sours into snobbishness, and a contribution to a philosophy of life to the effect that no phase of life is unworthy the attention of a scholar may well be emphasized over and over again by the engineer.

A second positive contribution to culture may well be the engineer's idea of tolerance. In general we think of tolerance as a kindly, somewhat careless virtue, whereby we recognize that there is much bad in the best of us and much good in the worst of us, and so why worry much about it. To the engineer, tolerance carries an entirely different meaning. He states, for example, that in making steel for rails there is allowed a tolerance of 1/20 of 1 per cent. of phosphorus. That does not mean that he refuses to worry about phosphorus in steel. He worries about it very much, and as a result of his intelligent worrying he has decided that the cost and the time of removing that last 1/20 of 1 per cent. of phosphorus from steel is very great, whereas the evidence of material damage done by such a small amount of phosphorus is very slight. Therefore, he places the line below which it is not wise to reduce phosphorus at this figure.

This idea of this sort of tolerance of those manners and morals which seem to us undesirable is suggested

as a contribution to culture. We should by no means be good-naturedly careless about the undesirable things, but we may well try to develop a careful discrimination in choosing those evil things which we will try to eliminate and the good things which we will try to encourage, and we realize that as absolute perfection is never reached in the chemical and mechanical world, so there are limits of perfection beyond which effort in the social and ethical world is ineffective, and that these limits are not fixed, but vary from age to age.

A third positive contribution which the speaker believes the engineer may make to culture is the pointing out of the fact that not infrequently development of abstract ideals may come as the result of daily work on the job. Perhaps such development may come from the day's work as often as from abstract thinking. In the engineer's professional life the immediate thing before him is always a job, but frequently as he wrestles with a job general ideas of the relation of his job to various other jobs and of the development of various values and general truths come to him. The engineer reacts with hearty approval to that statement of the Carpenter of Nazareth, "If ye do the will ye shall know of the doctrine," and the speaker believes that the engineer may well contribute to culture by the insistence of the fact that the road between the shops of the doers of jobs and the studies of thinkers of thoughts is not a one-way street.

The speaker has mentioned what he believes to be some positive contributions of engineering to culture. These contributions make up only a small part of the body of culture, and the speaker wishes to emphasize the fact that many phases of culture are outside the professional field of the engineer, and that he should cultivate an attitude of interest toward them, even though it is not feasible for him to make direct contributions to these phases. Very few engineers can make noteworthy contributions to music, yet the engineer may well regard music as important in the scheme of things.

The speaker believes that the greatest contributions of the engineer to culture are indirect contributions. Some early records of the Christian church, at Ephesus, have been unearthed, probably for the period about 300 A. D. In those records we find that the preacher of the church was set apart to his sacred office by the solemn laying on of hands. We find that the director of the music of the church was likewise ordained to his position with the solemn laying on of hands. We find also that the janitor—the sacristan—was ordained to his office with the solemn laying on of hands. They had some good ideas in those times. Apparently they recognized that the work of the man who saw that the church building was orderly, clean, and as well ventilated as possible was worthy of sacerdotal recognition. The engineer should be regarded as a sacristan for the temple of civilized society and the office of sacristan should be restored to its ancient Ephesian dignity. For the fine arts, the fine tastes, the fine manners *may* develop amid conditions of hunger, cold, poor housing and difficult transportation, but these conditions are usually handicaps and not helps.

I would urge to engineers, first, that they accept openly and unashamed their function as smoothers of the path for the development and refinement of manners and morals. I would urge that they insist upon the dignity of this work not noisily but firmly. The great artist who paints a picture before which men and women dream is more notable than the chemist who developed for him the pigments which he used and the textile expert who has made possible the canvas on which he paints, but the artist comes short of the full stature of culture if he holds chemists and textile experts in contempt. I am asking not for formal praise to the engineer as the smoother of the path, but I am asking him to keep his own inner conviction of the worthwhileness of his task, and to honor worthy writers, painters, musicians and artists, not as a higher class of beings, but as workers who also have done well.

But we may face the fact that with the smoothing of the path to finer manners, finer tastes, finer art there has developed a great tendency for people to loiter along the smooth path making their own existence a pleasant, aimless journey. Frequently the engineer is blamed for the fact that men have used in this lazy fashion the highway he has helped to prepare, or that some of them have actually walked backward on it toward the things that are ugly and cruel. The engineer physicist who has developed the modern talking, moving picture is blamed because there has developed so large a group of people incapable of entertaining themselves and who have become slaves to professional entertainment at so much per head. The automotive engineer is blamed for the daily crowds of people who go on joy rides and frequently spoil all pleasure for others in riding. The chemical engineer is blamed for the hellishness of poison gas warfare. Some blame must be taken by the engineer for this state of affairs. In common with the great multitude of people, he has failed to raise his voice very loudly against the abuse of the smooth roadways he has made possible. He, with others, has carelessly assumed that, given an easier pathway to the fine things of life, people will of

course seek them. But his blame is not greater than that of other groups of people. He must take his share of the blame, but he is not a sinner above other men in this respect.

The engineer, with other folk, must come to recognize that while clearing the ground is an important and dignified part of the process of building the temple of society, and that while in dignity and worthiness it is second to no other task, yet the clearing of the ground does not insure that a beautiful temple will be built, and that emphasis must be placed on the proper use of the facilities he has helped create. In considering the proper use of the facilities made available by applied science—surely a field of study of vital importance to culture—the speaker believes that the engineer may well emphasize the necessity of giving due consideration to the viewpoint of the workaday world—not on emphasis which overshadows the viewpoint of the leisurely scholar who is freed from anxiety for daily bread, but an emphasis which will cause attention to be given to *both* viewpoints—a really broad-minded emphasis. He may well emphasize the engineer's idea of tolerance. Moreover he must avoid the great error, rather common to the artist type, of the tendency to see everything outside one's own field through a reversed telescope, as small and unimportant. As the engineer demands that the dignity of his work for humanity be recognized, he must be willing to give adequate recognition to the view-points of preachers and economists, artists, and philosophers, authors and pure scientists.

SCIENTIFIC AND PHILOSOPHICAL METHODS IN EDUCATION[1]

By Professor FRANK N. FREEMAN
UNIVERSITY OF CHICAGO

THERE is precedent for the discussion of this topic before this association. Several years ago, Dr. Pechstein, the retiring vice-president, discussed the question, "Is there a science of education?" He presented the results of a questionnaire addressed to well-known students of the science of education. He left the impression that while education may not be classed as a science similar to physics, chemistry, biology or psychology, it may use scientific methods and hence may be regarded as an applied science similar to engineering or medicine. Perhaps scientific students of education will not quarrel about a name if it be admitted that the problems of education can be attacked by scientific methods. At the meeting a year ago, Dr. Kelley discussed a question which is somewhat more nearly related to the one we have before us at this meeting. He took as his specific problem the relation between science and philosophy as methods of study of educational problems. The solution which he offered was that both science and philosophy have a place in the study of education. The place of science is to determine the general principles which govern educational procedures and the place of philosophy is to deal with and to find the solution of particular or concrete issues. When the student of education formulates a general law or principle, then, he is scientific, but, when he faces a complex situation demanding that he decide what form of practical action should be taken, he has recourse to philosophy. Science is general, philosophy is particular; science is theoretical, philosophy is practical. We shall find in the course of our discussion that concepts of the nature of philosophy and of its applications in education are varied. This is one which we shall have to include in our list for consideration.

The existence of a precedent is perhaps hardly sufficient justification for discussing the relation between the philosophical and the scientific methods on the present occasion. It is true that the recognition of education as having a legitimate place in a scientific association immediately suggests the problem. It is also true that questions of method are quite appropriate for discussion in meetings at which scientists of various interests and types of training join together. But the subject has recently been discussed in other groups as well as in this one, and it may be thought to be a hackneyed question if not indeed an academic one. I believe, however, that the problem at issue merits some further consideration. The question may be hackneyed, but there is still a marked difference of opinion upon it. The philosophy of education is made a prominent part of the curriculum of some departments or schools of education and it is omitted as a distinct subject of instruction in others. A contrast between the philosophical and the scientific mode of approach is represented not only in courses of instruction but also in the thinking and

[1] Address of the retiring vice-president of Section Q—Education, American Association for the Advancement of Science, Cleveland, December 30, 1930.

the consequent practice of teachers and administrators in general. The issue cuts deeper than a mere theoretical or a verbal adherence to one or the other side of an academic issue. The philosophical and scientific methods are not merely complementary methods, the one suited to one type of situation and the other to another. They represent differences in emphasis which characterize different modes of approach to the same problem. One of these methods is, I believe, more productive than the other and more likely to lead to progressive improvement of educational practices. For these reasons it is worth while to continue the discussion of the problem.

We often speak of philosophy and science as though we all meant the same thing and knew exactly what we meant. As a matter of fact, neither of these assumptions is true. A great variety of things is meant by both philosophy and science, particularly as applied to education, and those who discuss the issue between these two methods very commonly do not recognize that they may be talking about quite different things. It will be worth while at the beginning, then, to run over some of the diverse conceptions of these two methods.

Conceptions of the meaning of philosophy as a method are probably more varied than are the conceptions of science, so we may begin with philosophy. Philosophy is sometimes used in a technical sense to designate a rather highly specialized discipline, having a long history and a definite field which it cultivates. This is the meaning which is attached to philosophy as a subject of study in universities. Certain parts of it are highly speculative. They are dealt with in *metaphysics* or the *theory of knowledge*. They are concerned with such questions as the ultimate nature of the universe or with the possibilities or limitations of our knowledge of reality. They deal with issues which divide philosophers into camps, such as the issue between realism and idealism. These and similar questions have divided philosophers for ages and seem likely to divide them for ages to come unless they turn their backs on the problems entirely and become pragmatists.

It is a little difficult to see how metaphysics or epistemology could have a direct bearing upon practical issues in education. In fact, it is difficult to see how they have a direct bearing on practical issues of any sort. The questions with which these disciplines deal are speculative and outside or beyond the realm of immediate experience. It is sometimes held that certain assumptions concerning the issues in metaphysics are necessary as a basis for the derivation of principles in the more practical discipline of ethics; but the modern treatment of ethics deals with it through a direct analysis of experience rather than through an appeal to speculative principles. This type of speculative philosophy is not widely represented among students of education and we may, therefore, dismiss it from further consideration.

It is rather a far call from philosophy of the type which has just been mentioned to philosophy as a settler of practical, concrete, immediate issues. It is rather difficult for one who is accustomed to thinking of philosophy as dealing with such problems as the nature of reality, the nature and existence of God, the possibility or necessity of freedom, or the possibility and limits of knowledge, to think of philosophy as represented in a process of deciding whether one should spend one's money to buy a new windmill or to send one's daughter to college, or again, whether one should accept a new job which offers novel attractions or remain in the old job and enjoy the advantages which are connected with it. This is quite a different meaning of the term, inconsistent with the first one. Philosophy, according to this usage, means weighing and balancing all the considerations on one side or the other of a practical issue and then throwing the weight of one's decision on the side which presents the greater advantages. The philosopher, according to this view, is not the absent-minded recluse sitting in his study and pondering the ultimate nature of the universe. The philosopher is rather the practical man of affairs; the administrator, a person of judgment and good sense who is able to make the right decision at the right time.

Lying back of this notion, apparently, is the view that the acquirement of an adequate philosophy will in some way give the individual such ability to weigh all the values of life that when a practical issue confronts him he will be able to refer to these values and thus find the decision as good as made for him. This is an alluring prospect, but it hardly seems borne out by the facts. The connection between the more abstract or speculative considerations and the practical ones which meet the individual in his daily life is after all a rather remote one. The illustrations of practical problems offered by proponents of philosophy as suitable for solution by the application of philosophical values have not usually been elaborated sufficiently to show in detail how these values may actually be applied to the solution of the problems in question. This conception of philosophy as a settler of practical issues, therefore, seems hardly to be a tenable one.

Another conception of philosophy regards it as a personal, individual reaction to the values or goods which are presented in life. Philosophy is the subjective aspect of one's reactions. A given person may like a thing or not like a thing, but there is no appeal beyond his taste. Another person disagrees

with him, but there is no common ground for discussion, much less of agreement. Each one's evaluation of his experiences is an ultimate, and there is no means of explaining it nor, as far as I can see, of changing it. This conception is sometimes put in physiological terms by saying that science is a product of the activity of the brain and central nervous system, while the philosophical attitudes or evaluations are the product of the autonomic system. These aspects of the world which one evaluates through this purely personal and individual mode of response can not, therefore, be studied scientifically, can not be subjected to the canons of right or wrong and can not be settled by majority vote.

This argument proves rather too much. If philosophy consists in attitudes which are so inaccessible to scientific study and are so subjective as to necessitate mere acceptance without evaluation by another person, this type of philosophy would deny the very root idea of philosophy itself, which is reasoned discussion. Such attitudes can form the basis for neither philosophy nor education. A category from which there is no appeal, either by scientific study or by reasoned discussion, could never serve as the basis for educational theory. Only a type of evaluation which gave some possibility of common agreement could ever furnish the basis for educational policy or procedure.

A more common conception regards philosophy as the determiner of ends or values and science in contrast as the determiner of means to the attainment of these ends. According to this conception philosophy is commonly regarded as different in essential nature from science. It pursues different methods and in reality occupies a different dimension of thought. The two do not mix. Each one has its clearly defined area of operation. Each performs certain necessary functions within its own area but is incapable of performing the functions which belong to the other method. This conception of philosophy as having the distinct problem of setting up goals or establishing values is suited only to the absolutist's conception of the nature of philosophy. Philosophy, according to this idea, determines ends or values, not by analyzing human experience, comparing the results of this or that type of behavior in terms of human satisfaction, but rather through some speculative or abstractly logical thinking process. It is interesting to note that this view of the matter seems to be held even by some educational philosophers who professedly adhere to the pragmatic doctrine.

One of the founders of pragmatism, Professor Dewey, is quite clear in repudiating this conception of the function of philosophy in education and of its relation to science. He says in his recent essay, entitled "The Sources of a Science of Education":

> It is sometimes said that philosophy is concerned with determining the ends of education while the science of education determines the means to be used. As one who is a philosopher rather than a scientist I might be inclined to welcome a statement which confers upon philosophy such an honorable position. Without a good deal of interpretation, it is, however, likely to give rise to more false than true conceptions.

Again,

> As far as ends and values are concerned, the empirical material that is necessary to keep philosophy from being fantastic in content and dogmatic in form is supplied by the ends and values which are produced in educational processes as these are actually executed. What a philosophy of education can contribute is range, freedom and constructive or creative invention. The worker in any field gets preoccupied with more immediate urgencies and results. When one begins to extend the range, the scope, of thought, to consider obscure collateral consequences that show themselves in the more extensive time-span, or in reference to enduring development, that one begins to philosophize whether the process is given that name or not. What it terms philosophy is only a more systematic and persistent performance of this office.

In another place Professor Dewey protests against the psychologist confining himself to the study of such processes as learning to read without considering the broader effects upon the child's mental development of learning in one way or another. He says:

> It will not do for the psychologist to content himself with saying in effect: ''These other things are none of my business; I have shown how the child may most readily and efficiently form the skill. The rest is up to somebody else.'' It will not do because one skill is acquired, other abilities, preferences and disabilities are also learned, and these fall within the province of the psychological inquirer. (sic)

It is, of course, equally true that a philosopher is not justified in saying to the psychologist, "The study of these minute details are in your province but the consideration of the larger issues are not your business at all." It is only a narrow conception of the meaning and function of psychology or of science in general which confines it to the more minute and technical problems of investigation. There is, in fact, no definite and rigid demarcation between the study of values or ends and the study of means. Professor Dewey dwells on this point emphatically. In fact, it is an essential feature of the pragmatic doctrine that values develop in the course of activity and are not worked out by abstract reflection alone and imposed upon the experience of everyday living.

If values and ends are not drawn down from the thin air, but rather grow out of our experience in meeting the exigencies of practical life and of reflection upon them, and if this reflection constitutes the method of philosophy, it is obvious that philosophy and science deal with the same material. It seems further evident that the methods are not necessarily diametrically opposed but rather overlap one another to a large degree.

The question now arises as to whether, as science develops its method of analyzing human experience, it may not offer a more refined and more reliable method of deriving values and ends than the purely observational and reflective method which characterizes philosophy. The point of view here suggested is that philosophical reflection serves provisionally as a means of evaluating procedures, but that it must give place to science as rapidly as science can perfect its methods of analysis. The values which are set up by this analysis must justify themselves in experience instead of being justified on the criterion of internal consistency, logical coherence or the appeal to individual preferences. The values must be regarded as hypothetical rather than as ultimate. The variations in values which are found to obtain in the societies of different peoples must be evaluated in terms of their outcomes in the lives of these peoples.

In attempting to evaluate forms of education, or, more broadly, forms of human organization or behavior, science seems justified in accepting a few basic assumptions, if not ultimately, at least provisionally. For example, it seems safe to assume certain conditions of body and mind as desirable and their opposites as undesirable. These are not to be regarded as ultimate ends but only as elements in a general scheme of values. General consensus of opinion would seem fairly to support the acceptance of these items as universally good: life itself, the prolongation of life, zest in life and the desire to live, a generally pleasurable feeling tone, the vigorous and effective performance of the fundamental functions of life, health of body and of mind, the development of those forms of social organization which promote these ends and the progressive enrichment of human experience. Those forms of treatment of the child and those forms of behavior which, in general, promote these and similar ends may in so far forth be regarded as worthy, and those which hinder them, in general, and in the long run, may be regarded as undesirable. These very assumptions themselves should not, of course, be regarded as beyond the pale of analysis or investigation, but the acceptance of some such assumptions will be found, I believe, to underlie our judgments concerning human values. This is true whether we think philosophically or proceed scientifically. The difference in the procedure is that, in the one case, we depend upon casual observation for the data with which to make our analyses and to draw our conclusions, whereas, in the other case, we collect our data systematically.

We have seen that in so far as philosophy deals with experience rather than with speculation, it deals with the same material as science and its methods may even shade into the method of science. The same relation holds with reference to the use of the hypothesis in thinking and in scientific investigation. Philosophers have sometimes regarded it as their function to examine the unrecognized hypotheses or assumptions which underlie the procedure of scientific workers. It is, of course, the privilege of any competent critic to examine the hypotheses which underlie the procedure of scientific workers or of speculative thinkers. Just why one group should adopt the specialized function of examiner of hypotheses, however, is not quite so clear. It would seem to be the duty of any scientific worker who undertakes to interpret the data with which he deals to examine the assumptions which underlie his own conclusions and not to rely upon someone else to perform this function for him. The person who makes scientific investigation should assume the responsibility for interpreting his data and his findings and for thinking through his arguments clearly from the foundation to the conclusion. Experimenting does not absolve the scientist from the duty of thinking and of observing the canons of correct thought. He may receive thankfully any suggestions from any qualified person whatever regarding errors in his procedure or in his interpretation, but he can not be satisfied with the division of labor which absolves him from thinking about his own findings as profoundly as he can.

A slightly different function which is sometimes regarded as a special problem of philosophy is the setting up of hypotheses. It has been pointed out that fruitful hypotheses are sometimes suggested by speculative thinkers before they have been thought of, much less tested, by scientists. The theory of evolution is cited as an example; and the laws of falling bodies, which were investigated by Galileo, constitute another example. These, however, are rather ancient instances and they occurred at a time when philosophy and science had not become distinguished from each other. The same person was likely to be both a philosopher and a scientific worker, as illustrated in the person of Aristotle. Science was in the early stages of its development when the known facts were not very numerous and the technique of scientific investigation had not been elaborated. It should be pointed out further that philosophical hypotheses, such as that of evolution, remain com-

paratively unfruitful until they are attacked by the elaborate and detailed methods of science. Furthermore, and this is perhaps a more serious matter, the speculative thinker who derives an hypothesis but is not equipped with the technique or has not acquired the habit of scientific investigation, is very likely to treat his hypothesis as a theory or even as an established principle and to neglect altogether the necessity for verification. If one does not check up on one's guesses or hypotheses by painstaking investigation it is fatally easy to pass by imperceptible stages from a guess to an hypothesis, from a hypothesis to a theory, and from a theory to an established principle. It is to be feared that much of our so-called philosophy of education consists of little more than principles derived in this fashion.

If hypotheses are to be fruitful they should be kept in as close relation as possible to observed or objectively described situations. They should grow out of actual problems which are presented concretely and in detail. They should be tested and verified or rejected by further observation, supplemented, if possible, by statistical and experimental investigations. This is the scientific method. No scientific investigation of any serious consequence can be carried on without the employment of hypotheses. They are part of the indespensable stock and trade of the scientific worker.

This fact is not only a commonplace of scientific methods; it is in strict accord with the principles of pragmatic philosophy. Pragmatic philosophy, in fact, is simply the philosophical justification of the scientific method. It means that, so far as the practical control of the affairs of living is concerned, such control must be worked out and exercised by experimental adjustment to the practical conditions of life itself. It can not be turned over to the absentee control of pure reason or speculative thought, elaborated in seclusion from the conditions which life presents and the problems which are involved in them. This means the development of principles through experimental procedure; and experimental procedure is the method of science.

It is obvious that science has been used in this discussion in the broad sense of the term. The critics of science as the predominant method of control of the procedures of education frequently restrict science to the more rigidly technical forms of scientific research, and sometimes restrict their consideration to the past achievements of science in education without regard to the possibilities of its future development. The exponent of science in education can well afford to be modest concerning its past achievements and even concerning the techniques which have been developed up to the present time. The contention is not that science has yet established a basis for all the procedures of education or even for a considerable part of them. For the length of time it has been in operation, the scientific method has given a fair account of itself. The main contention of this paper is that it is the scientific method rather than the philosophical method which offers the possibility of continuous and sure advancement toward a more and more adequate solution of the problems of education. When science has once conquered a bit of territory, that territory is acquired in permanent possession. Mistaken theories may be adopted which are later shown to be unfounded, but in general science moves steadily onward.

Genuine philosophical speculation has its own canons of criticism. It may, within its own sphere, be as rigid and as careful as is scientific investigation. Those who pursue philosophical speculation, however, recognize the limitations of its sphere. They do not undertake to make it do a work for which it is not fitted, namely, to determine the issues of practical living. One who is not interested in the pursuit of speculative philosophy may adopt pragmatism, which eschews speculative problems and busies itself with the problems of practical living. Such a person must realize, if he thinks his way to the end, that the ultimate goal of such a procedure is a wholehearted adoption of the scientific method. He can not stop at any half-way point. If he does, he abandons the canons of one rigid discipline without taking over the canons of the other discipline which properly takes its place.

The issue is one of practical importance. The contrast between what often passes for the philosophy of education and the pursuit of the science of education is too often the contrast between a method of thought in which the thinker is unwilling to take the laborious and painful course of checking up his opinion step by step and the method in which the attempt is made to subject one's thinking to careful verification. The habit of building up a structure of opinion without constant and painstaking weighing of evidence and without constant reference to particular facts for the purpose of verifying and correcting these opinions is all too easy to acquire and all too difficult to outgrow. No one would probably lay claim to having entirely outgrown this insidious habit. It is within the province of every one, however, to declare his commitment to a method which requires that opinion shall grow out of detailed examination of all the facts pertinent to the problem, and as complete a testing of his opinion as the technique at his command will

allow. In dealing with those problems to which the scientific method of investigation has not yet been successfully applied we shall all need to philosophize, that is, to use our best judgment in the light of the facts which are available to us. This philosophizing, however, can best be done as an integral part of the consideration of each particular educational problem. There is no justification for setting apart those aspects of educational problems on which the evidence is not yet complete and treating them in a separate discipline. Furthermore, we may look forward to the gradual reduction in the scope of problems which must be attacked by this method, and we should use our best efforts to enlarge the scope of those problems which may be successfully attacked by the scientific method.

OBITUARY

WALDEMAR M. W. HAFFKINE

THE sudden death on October 27 in Lausanne at the age of seventy of Dr. Waldemar M. W. Haffkine, bacteriologist and immunologist, deprives the world of one of its most illustrious scientists. Inasmuch as Haffkine's work in combating and, to a large extent, conquering epidemic scourges was of universal benefit and inasmuch as his career as an investigator was truly international—being carried on under the auspices of various nations and races—it is appropriate to devote a few words of appreciation to his memory in SCIENCE.

Dr. Haffkine was born in Odessa, in southern Russia, on March 15, 1860. At the age of twelve he entered the gymnasium at Berdiansk and from the very first he exhibited a bent of mind in the direction of science and experimental investigation. In 1879 he entered the University of Odessa as a student in the faculty of science and in 1883 he took his degree of doctor of science. He remained at Odessa for five years, working in a laboratory fitted out for his special use in connection with the zoological museum of the university, and devoted himself to the study of difficult problems relative to the fundamental phenomena of organic life. At the beginning of 1888 he was appointed assistant to Dr. Schiff, professor of physiology in the University of Geneva, a position which he held for a year and a half. About the middle of 1889 he found his true sphere of work on being called by Pasteur to Paris. He became one of Pasteur's most eminent pupils.

In Paris he began the study of typhoid fever and cholera and soon discovered the principle and method of inoculation with attenuated virus against the latter. As early as 1891 his work along that line had progressed so far that when Prince Damrouy, brother of the King of Siam, called on Pasteur and asked him to supply a remedy for cholera, the illustrious scientist referred him to Haffkine for aid. A few months later Haffkine's first paper on the subject was given to the world.

The two of Haffkine's most important contributions to the science of medicine are his investigations of the devastating scourges, cholera and the plague. It is perhaps in connection with cholera that Haffkine is better known. In 1893 he went to India to conduct investigations on cholera for the Indian Government, making Calcutta his headquarters and extending his operations over the whole of Bengal and into the Punjab, the Northwest Province and Assam. In 1896 he was deputed by the Indian Government to inquire into the bacteriology of the plague and to devise means of combating it. Here again he discovered an effective method of inoculation and succeeded in reducing the mortality from 80 to 90 per cent. In recognition of his services to the British Government, he was created Companion of the Order of the Indian Empire. The Haffkine method of inoculation for both cholera and plague has been generally adopted throughout the Orient, and the government research laboratory which he founded issues many thousands of doses of vaccine for the effective inoculation and treatment of epidemics in various tropical countries.

Haffkine's contributions to biological research and medicine include various monographs and official reports not only on the cholera and the plague but also on a variety of other subjects, heredity, biology of monocellular organisms, general problems of bacteriology, etc. Although retired from active work for the past few years, he continued to interest himself in various scientific investigations, which he carried on particularly at Lausanne.

Haffkine's work on cholera and the plague places him in the class of those pioneers in medical research who have immortalized their names through the alleviation of suffering and reduction of mortality caused by such wide-spread infections as malaria, diphtheria, yellow fever and trypanosomiasis. As a scientist, Haffkine was meticulously careful and accurate in his work as well as ingenious in his methods. As a man, his character might be summed up in the following words, a quotation from a letter received by the writer from Dr. M. Ascher, Bex, Switzerland, who attended the funeral: "Great was his scientific work in that he literally saved millions of lives but equally great was the personal character of the man and, most particularly, his modesty and humility. He never asked for help from any man but he was always ready to help

others and befriend the needy." The memory of Waldemar M. W. Haffkkine will be cherished not only by those who had the privilege of being his friends and those who are devoted to the advancement of medical science but also by all those interested in the promotion of human welfare and the betterment of the race.

David I. Macht

Director, Pharmacological Research
Laboratory, Hynson, Westcott & Dunning, Inc.,
Baltimore, Md.

E. GLEY

To American biologists has come the tardy news of the death of Professor E. Gley on October 28. Professor Gley endeared himself to every one with whom he came in contact. In spite of his seventy years, his electric vitality enthused every one about him. Those who heard his address at the International Congress of Physiologists at Stockholm in 1926 and the address given at the International Congress in Boston in 1929 recognized in him not only the savant but a man of the widest international interests. One of the first to extend the hand of friendship to the opposed nations of the war, Professor Gley has done a great deal to reestablish international amities. About his hospitable table at his home in Paris one could be sure to meet a representative of nearly every country of Europe. His loss will be very severely felt by the Collège de France, for in a relatively short time the Station Physiologique has lost not only M. Pézard but now Professor Gley. Working with a wholly inadequate laboratory and under almost impossible conditions, Professor Gley maintained high scientific standards and his loss to biological science as a whole is irreparable. Ever expressing his enthusiasm for France, Professor Gley was extraordinarily international-minded and not only has biology lost a great scientist and France a great citizen, but the world has lost a great man.

Francis G. Benedict

MEMORIALS

A memorial meeting to the late Dr. Thomas W. Salmon was held at the New York Academy of Medicine on January 10. The committee in charge has collected $100,000 to establish a permanent memorial. This will take the form of an award to be made each year to a psychiatrist who has, during that period, made distinguished contributions in the field of psychiatry and mental hygiene. He also will be chosen to give the Thomas W. Salmon lectures. Speakers at the memorial meeting included Mr. George W. Wickersham, chairman of the committee, and Dr. Harry Emerson Fosdick.

The College of Forestry of Syracuse University was closed at 12:00 o'clock January 5 for the balance of the day in honor of the memory of Professor John W. Stephen, head of the department of silviculture. Professor Stephen, after having joined the faculty of forestry as one of its pioneer members in 1912, was soon promoted to the rank of professor, and was appointed head of the silviculture department in which capacity he has served since. The books and articles which he wrote concerning his field of work include "Making Best Use of Idle Lands in New York," "Basket Willow Culture in New York," "Forest Conditions in Oneida County," and "Top-Lopping of Branches in Lumbering Conifers." Professor Stephen was a native of Michigan and was graduated from both Michigan Normal College and the University of Michigan. He received an A.B. degree in 1907 and an M.S.F. degree in 1909 from the latter institution. While on leave from Syracuse University in 1915, he received the degree of M.Ped. from Michigan Normal. He became a state forester in New York in 1908, being given charge of the state tree nursery at Salamanca. He was a member of Sigma Xi fraternity, a fellow of the Society of American Foresters and a member of Phi Kappa Phi, honorary scholastic fraternity.

RECENT DEATHS

Dr. Henry Leffmann, professor of chemistry at the Wagner Free Institute, Philadelphia, an honorary member of the Franklin Institute, died on December 25. Dr. Leffmann was eighty-three years of age.

Dr. Charles Krumwiede, professor of hygiene and bacteriology at New York University and assistant director of the New York Health Department's research laboratory, died on December 28, at the age of fifty-one years.

Mr. George G. Ainslie, associate entomologist of cereal and forage insect investigations of the Bureau of Entomology at West Lafayette, Indiana, died on December 19.

The death is announced of Professor John Munro, emeritus professor of mechanical engineering at the University of Bristol at the age of eighty-one years, and of Professor Eugene Goldstein, of Berlin, at the age of eighty years.

SCIENTIFIC EVENTS

THE MONONGAHELA NATIONAL FOREST

Eight meetings were held at various points contiguous to the Monongahela National Forest on January 5, for the purpose of taking concerted action at a general meeting toward securing an adequate allocation of forest funds for the construction of roads and trails and the relief of the unemployed.

Initial action was taken by the Elkins Business

Men's Association and a letter was sent out recently calling meetings at the courthouse at Petersburg, Grant County; at the courthouse at Franklin, Pendleton County; at the Durbin Junior High School in Pocahontas County; at the courthouse at Marlinton, Pocahontas County; at the Board of Trade Office at Davis, Tucker County; at the Glady Church, in Randolph County; at the Stockmans Bank at Harman, and at the Young Men's Christian Association at Elkins.

Three things were to be considered at these meetings:

Plans for obtaining the allocation of $400,000 for the construction of roads and trails and for the relief of unemployed.

How to secure approval of four projects as recommended by the United States Forestry Service at Elkins. These four projects embrace the construction of a road from Corners, in Grant County, to Upper Tract, in Pendleton County, known as the Smoke Hole project; the construction of a road from Porterwood, in Tucker County, to Harpertown, in Randolph County, known as the Shavers Fork project; from Bartow, in Pocahontas County, to Judy Rocks, in Pendleton County, known as the Elk Mountain project, and from Hendricks, Tucker County, to Red Creek, known as the Dry Fork project.

The appointment of a committee of three from each community to meet in Elkins, when there would be perfected an organization to promote the development of Monongahela Forest, which constitutes one of the general conservation projects of the government through the reforestation of the area.

RESEARCH AND INDUSTRY AT PURDUE UNIVERSITY

Rapid development of research work at Purdue University in connection with the industrial growth of the state was emphasized with the filing of articles of incorporation of the Purdue Research Foundation. The organization of the foundation marks another epoch in the influence of the university and gives a new impetus to the extensive research program of scientific research.

The foundation is a non-profit organization and has no capital stock. Its purpose is to assist in the financing of the research projects and handling of matters pertaining to inventions and patents for the benefit of the state at large, the university and industrial organizations directly concerned.

Calls upon the university by industries of Indiana, especially during the last few years, for assistance in solving scientific problems vital to their growth have increased with the growing economic importance of the state in national affairs. Recognizing the need for more constructive cooperation the board of trustees of the university in 1927 authorized organization of a special department to handle research relations with industry. Mr. G. Stanley Meikle, a well-known consulting engineer, was chosen director of the newly created department. As a result of his work, direct cooperation between industry and the university has grown rapidly. This has led to the organization of the foundation to assume the legal and financial responsibilities of the rapidly expanding research program.

The board of directors for the foundation, representing the founders, the board of trustees of the university, Purdue alumni, and the national engineering and research councils, includes the names of widely recognized men. The names of the directors follow: J. R. Francis, Flint, Michigan, president of the Marvel Carburetor Company; J. K. Lilly, Indianapolis, president of Eli Lilly and Company, and trustee of Purdue; David E. Ross, Lafayette manufacturer and inventor, and president of the Purdue Board of Trustees; G. Stanley Meikle, director of research relations with industry; L. A. Downs, Chicago, president of the Illinois Central Railroad; L. W. Wallace, Washington, D. C., executive secretary of the American Engineering Council; President E. C. Elliott, of the university; James W. Noel, Indianapolis attorney, and James L. Kimbrough, Muncie, treasurer of the Indiana Bridge Company, both trustees of the university; Robert M. Feustel, Fort Wayne, executive vice-president of the Midland United Company, and president of the alumni association; D. M. Buchanan, Chicago, president of the Old Ben Coal Corporation, and William L. Batt, of New York City, president of the S. K. F. Industries, bearing manufacturers.

FRANKLIN INSTITUTE LECTURES

The following lecture program has been arranged by the Franklin Institute of Philadelphia:

January 15.—Dr. Charles A Kraus, director of chemical research, Brown University, on "Solutions of Metals in Non-Metallic Solvents: Some of their Physical and Chemical Properties."

January 21.—Igor I. Sikorsky, vice-president, Sikorsky Aviation Corporation, Bridgeport, Connecticut, on "The Future of Large Aeroplanes."

January 29.—Dr. George A. Richter, director of research, Brown Company, Portland, Maine, on "Researches on Wood Fibers as a Paper-making Material."

February 5.—Dr. Arne F. Westgren, secretary for physics and chemistry, Nobel Prize Committee, Stockholm, Sweden, on "Crystal Structure and Atomic Products of Alloys Containing Transition Elements."

February 18.—Dr. K. C. D. Hickman, research laboratory, Eastman Kodak Company, Rochester, New York, on "High Vacuum Technique in Chemical Work."

February 26.—Dr. V. K. Zworykin, engineering department, research division, R. C. A. Victor Company, Inc., Camden, New Jersey, on "Photo Cells in Theory and Practice."

March 5.—Dr. Judson Daland, Graduate School of Medicine, University of Pennsylvania, on "The Evolution of Modern Printing and the Discovery of Movable Metal Type by the Chinese and Koreans in the Fourteenth Century."

March 18.—Dr. Walter Renton Ingalls, director, American Bureau of Metal Statistics, New York City, on "The Wealth of Nations, With Especial Reference to That of the American People."

March 26.—Dr. Samuel A. Mitchell, director, McCormick Observatory, University of Virginia, on "The Structure of the Atom Under Conditions of Temperatures and Pressures in the Sun's Atmosphere."

April 2.—Captain Nicholas H. Heck, chief, Division of Terrestrial Magnetism and Seismology, U. S. Coast and Geodetic Survey, on "Earthquakes and the Engineer."

April 9.—Nevin E. Funk, vice-president in charge of engineering, Philadelphia Electric Company, on "The Economic Value of Major System Interconnections."

April 15.—Dr. W. F. G. Swann, director, Bartol Research Foundation of The Franklin Institute, on "Report on the Work of the Bartol Research Foundation."

THE BAUSCH MEMORIAL BRIDGE AT ROCHESTER

ON New Year's Day, the city of Rochester dedicated its newest and finest span across the Genessee River as the Bausch Memorial Bridge in honor of John Jacob Bausch, the founder of the Bausch & Lomb Optical Company. The tablet unveiled during the dedication exercises has the inscription here reproduced.

This tablet was unveiled by Eleanor Eisenhart, great granddaughter of John Jacob Bausch, after a speech by Dr. Rush Rhees, president of the University of Rochester:

BAUSCH MEMORIAL BRIDGE
ERECTED 1930
BY THE CITY OF ROCHESTER
**
BY THE WILL OF THE PEOPLE A MEMORIAL TO
JOHN JACOB BAUSCH
PIONEER MANUFACTURER AND INDUSTRIAL
LEADER, WHO GAVE ROCHESTER LEADERSHIP
IN AMERICA'S OPTICAL INDUSTRY.

A correspondent in sending us this information writes:

In many ways this is regarded as a most fitting tribute. The first bridge to span the river at this point was built in 1873 and the following year the first company-owned Bausch & Lomb plant was built immediately adjacent to it. The plant and the bridge have "grown up together" and it is a coincidence that the new Bausch Memorial Bridge was built in the year that marked the one hundredth anniversary of the birth of John Jacob Bausch.

John Jacob Bausch was born in Gross Suessen, Germany, July 25, 1830. He died in Rochester, New York, February 14, 1926. Perhaps no more fitting epitaph to his life may be found than that written by his own hand. "My life has been a modest one, and was for a long time a struggle for existence. With heavy toil and in the face of many difficulties I was forced to meet its exigencies in early years. Failures have frequently fallen to my lot, but I have never given up hope, and have been astonished frequently at the success which has crowned my efforts in the end. Of a peaceful disposition by nature I have maintained pleasant relationships with my fellow men. Spiritually and morally I have always sought to do my best and have dishonored my family with no stain."

One fortunate circumstance, the importance of which can hardly be overestimated, was his friendship with Henry Lomb. Dating almost from the beginning of his struggle in America this partnership which was spiritual as well as material endured through every vicissitude until they were parted by the death of Captain Lomb, in 1908.

SCIENTIFIC NOTES AND NEWS

FOR the centenary meeting of the British Association, to be held in London from September 23 to 30 under the presidency of General Smuts, the following sectional presidents have been appointed: Section A (Mathematical and Physical Sciences), Professor Sir J. J. Thomson; B (Chemistry), Brigadier-General Sir Harold Hartley; C (Geology), Professor J. W. Gregory; D (Zoology), Professor E. B. Poulton; E (Geography), Sir Halford Mackinder; F (Economic Science and Statistics), Professor E. Cannan; G. (Engineering), Sir J. Alfred Ewing; H (Anthropology), Professor A. R. Radcliffe Brown; I (Physiology), Dr. H. H. Dale; J (Psychology), Dr. C. S. Myers; K (Botany), Professor T. G. Hill; L (Educational Science), Sir Charles Grant Robertson; M (Agriculture), Sir John Russell. On Wednesday, September 23, the ceremony of installing General Smuts as president of the association and a reception of delegates will be held in the Albert Hall during a private view of the exhibition which is being arranged in connection with the Faraday centenary celebrations.

THE Perkin Medal, awarded annually "to the American chemist who has most distinguished himself by his services to applied chemistry," was presented at Columbia University on January 9 to Dr. Arthur D.

Little, of Cambridge, Massachusetts, at a joint meeting of the Society of Chemical Industry, the American Chemical Society, the Société de Chimie Industrielle and the American Electrochemical Society. Dr. Little spoke on "The Evaluation of Chemical Projects." Other speakers were Professor Frederick G. Keyes, of the Massachusetts Institute of Technology, and Professor Marston T. Bogert, of Columbia University. A dinner at the Faculty Club preceded the meeting. The Perkin Medal was founded in 1906 at the time of the Perkin semi-centennial celebration of his coal-tar discoveries, the first medal being awarded to Sir William H. Perkin himself.

DR. ADOLF MEYER, professor of psychiatry at the Johns Hopkins University and director of the Henry Phipps Psychiatric Clinic at the Johns Hopkins Hospital, was made on January 10 the first recipient of the lectureship award under the recently established Thomas W. Salmon Memorial. The award carries an honorarium of $2,500 to be given annually to a man chosen to deliver the lectures at the New York Academy of Medicine because of his outstanding contribution to psychiatry.

THE Stephen Hales prize "in recognition of service to the science of plant physiology" was awarded to Dr. W. W. Garner, physiologist in charge of tobacco and plant nutrition investigations, U. S. Department of Agriculture, at the annual meeting of the American Society of Plant Physiologists, held at Cleveland on December 29, 30 and 31. This award, established in 1927 by the society in honor of the pioneer plant physiologist for whom it is named, consists of a diploma and a cash sum and was awarded to Dr. Garner for his discoveries of the effect of the length of day on the growth of plants.

DR. WILLIAM H. WELCH, professor of the history of medicine at the Johns Hopkins University, was elected president of the History of Science Society at the recent Cleveland meeting.

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, director of the American School of Prehistoric Research, was elected president of the American Anthropological Association at the recent annual meeting of the association held in Cleveland.

PROFESSOR GEORGE JAMES PEIRCE, of Stanford University, has been elected president of the California Botanical Society.

THE council of the Royal College of Surgeons of Canada recently conferred the honorary fellowship of the college on Dr. Frederick G. Banting, of the University of Toronto, co-discoverer of insulin.

AT a recent joint meeting of the board of trustees and scientific governors of the Chicago Academy of Sciences, the following honorary curators were elected: invertebrate paleontology, Dr. John R. Ball, of Northwestern University; paleobotany, Dr. Adolf C. von Noé, University of Chicago; botany, Dr. H. S. Pepoon, now associated with the Illinois Natural History Survey; mammalogy, Mr. Tappan Gregory; entomology, Dr. Frank J. Psota; oology, Mr. E. R. Ford. The Chicago Entomological Society, the Illinois Audubon Society, and the State Microscopical Society of Illinois have recently become affiliated with the academy as sections.

DR. FREDERICK BECKE, professor of mineralogy in the University of Vienna, celebrated his seventy-fifth birthday on December 31.

Nature calls attention to the birthday anniversaries last month of three British veteran workers in science. It writes: "On December 12 last Professor W. C. Unwin, 'a master and teacher of the science of engineering'—to use the appraising words of the late Sir William White—entered on his ninety-third year. He was born at Coggeshall, Essex, in 1838, educated at the City of London School, and began his notable technical career as a pupil in the firm of William Fairbairn, Manchester. Professor Unwin was elected to the fellowship of the Royal Society in 1886. Dr. William Garnett, who was born at Portsea, will celebrate his eightieth birthday on December 30. Like Professor Unwin, he was educated at the City of London School. Proceeding to St. John's College, Cambridge, he graduated fifth wrangler. Entering the Cavendish Laboratory, Dr. Garnett enjoyed the distinction of being the first demonstrator of physics there under James Clerk Maxwell. From 1904 until 1915, Dr. Garnett was educational adviser to the London County Council. Professor S. H. Vines, who was elected a fellow of the Royal Society in 1885, will be eighty-one years of age on December 31. A graduate of Christ's College, Cambridge, he was formerly Sherardian professor of botany in the University of Oxford."

AT the annual meeting of the Mineralogical Society of America, which was held at Toronto from December 29 to 30, in conjunction with the Geological Society of America, the following officers were elected for 1931: *President*, Alexander H. Phillips, Princeton University; *Vice-president*, William F. Foshag, U. S. National Museum, Washington, D. C.; *Treasurer*, Waldemar T. Schaller, U. S. Geological Survey; *Secretary*, Frank R. Van Horn, Case School of Applied Science; *Editor*, Walter F. Hunt, University of Michigan; *Councillor 1931–34*, William S. Bayley, University of Illinois.

AT the annual meeting of the Mathematical Association of America the following officers for 1931 were elected: *President* (two years), Dr. E. T. Bell, of the California Institute of Technology; *Vice-presidents*, Professor Arnold Dresden, of Swarthmore College, and Professor C. N. Moore, of the University of Cincinnati; *Members of the Board of Trustees* (for three years), Dr. L. L. Dines, of the University of Saskatchewan; Dr. T. C. Fry, of the Bell Telephone Laboratories; Dr. J. W. Glover, of the Teachers Insurance and Annuity Association, and E. P. Lane, of the University of Chicago.

DR. EDWARD A. BOYDEN, professor of anatomy at the University of Alabama, has been appointed to succeed Dr. Richard E. Scammon as professor of anatomy at the University of Minnesota. Dr. Boyden will move to Minnesota on June 1.

ANNOUNCEMENT is made of the appointment of William Maughan as assistant director of Duke Forest and assistant professor of forestry in Duke University, effective on January 1. Mr. Maughan's first work at Duke University will be to organize the Duke Forest as an operating demonstration of research and forestry in cooperation with Dr. C. F. Korstian, director of the forest and professor of silviculture. Plans are being formulated to develop a program of research which will be followed eventually by the organization of forestry educational work. This will probably be graduate work, largely of a research nature, leading to the higher degrees in forestry.

DR. HUGH E. BURKE has assumed his work as director of the research laboratory at the New York State Tuberculosis Sanatorium, Ray Brook, succeeding Dr. David T. Smith, who, after five years' service, resigned to become associate professor of medicine at Duke University School of Medicine, Durham, N. C.

THE appointment of W. P. Yant, supervising chemist of the health laboratory of the U. S. Bureau of Mines, as supervising engineer of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, Department of Commerce, is announced by Scott Turner, director of the bureau. Mr. Yant succeeds G. St. J. Perrott, who has accepted a position on the research staff of the A. O. Smith Corporation, Milwaukee, Wisconsin.

CHRIS L. CHRISTENSEN has resigned as secretary of the Farm Board to become dean of the College of Agriculture at the University of Wisconsin. Prior to his association with the Farm Board since its organization in July, 1929, Mr. Christensen for three years was head of the division of cooperative marketing of the Department of Agriculture.

MR. T. W. FAGAN has been appointed to the professorship of agricultural chemistry at University College, Wales.

MR. W. J. PUGH has been appointed professor of geology and director of the geological laboratory of the University of Manchester, from September, 1931.

DR. DAVID RIESMAN, professor of clinical medicine in the University of Pennsylvania School of Medicine, has been appointed consultant to the committee on the costs of medical care.

SIR GEORGE NEWMAN will be Heath Clark lecturer at the University of London for the year 1931.

THE Medical Research Council has, according to the *British Medical Journal*, awarded three Dorothy Temple Cross Research Fellowships for 1930–31, these being the first appointments to be made under the terms of the recent benefaction in that name for research fellowships in tuberculosis, as follows: Arthur Ivan Granville McLaughlin, chief assistant, tuberculosis department, St. Thomas's Hospital, London; Reginald John Matthews, chief tuberculosis officer, Mid-Glamorgan area, and medical superintendent, Cymla Hospital; Sidney Malcolm Burrows, lieutenant, attached Sudan Defence Force. Dr. McLaughlin has received a fellowship for the study of methods of diagnosis and treatment at some chosen center in the United States. Dr. Matthews and Lieutenant Burrows have received senior fellowships, and will make special studies of problems of tuberculosis among the native populations in Zanzibar and in the Bahr-el-Ghazal province of the Sudan, under arrangements made by the council with the respective governments.

DR. S. A. MAHOOD, of the department of chemistry of Tulane University, is on leave from the university for the session 1930–31, and is spending the year on special synthetic work in organic chemistry as Squibb's Research Fellow at Yale University.

DR. FRANZ ALEXANDER, of the University of Chicago, delivered the fourth Harvey Society lecture at the New York Academy of Medicine on January 15. His subject was "Psychoanalysis and Medicine."

DR. ELWOOD MEAD, commissioner of reclamation in the Department of the Interior, gave an illustrated lecture on "The Boulder Canyon Project" in the Aldred Series at the Massachusetts Institute of Technology on January 9.

PROFESSOR JAMES H. MCGREGOR, of Columbia University, gave on January 13 an illustrated lecture on "Primitive Man" before the Middletown, Connecticut, Scientific Association.

SIR D'ARCY POWER, of London, spoke on "The Royal Gift of Healing" before the College of Physicians of Philadelphia on December 8.

THE annual meeting of the American Heart Association will be held on Monday, February 2, at the Academy of Medicine, New York City.

THE First Congress of Latin American Ophthalmology will be held at Santiago (Chili) in 1931, under the presidency of Professor Charlin.

THE French Government has accepted an offer of the Rockefeller Foundation to establish a center for the study of undulant fever at Montpellier.

ADDITIONAL details in regard to the new observatory to be erected near Toronto by Mrs. D. A. Dunlap and her son, D. Moffat Dunlap, as a memorial to the late David A. Dunlap, who died in 1926, have been sent to us by a correspondent. Its distinguishing feature will be a 74-inch reflecting telescope, which is now being constructed by Sir Howard Grubb, Parsons and Co., of Newcastle-on-Tyne, England. Sir Charles Parsons, the proprietor of this firm, is the youngest son of the Earl of Rosse, who built the famous 6-foot reflector at Birr Castle some eighty-five years ago. The great telescope will be housed in a circular sheet metal building, as is usual now, while the offices and other necessary accommodation, together with auxiliary instruments, will be in a separate building which will be fine architecturally. The observatory will be located not far from Toronto but the exact site has not been determined. It is intended to have it in the midst of a park. When completed the observatory will be presented to the University of Toronto and will be under the department of astronomy.

AT a recent meeting of the deans of the professional colleges and the director of Hooper Foundation for Medical Research of the University of California, it was voted to apply the term, "Medical Center," to the schools, colleges and research centers considered collectively. The Medical Center is now taking steps to protect California from tropical and Oriental diseases which might be brought in through development of world commerce. To centralize efforts in this direction the regents of the university recently authorized the inauguration of a Pacific Institute of Tropical Medicine, and this organization is now functioning on many projects.

A CHEMICAL map of North America, the first attempt of its kind to show the wide range of sources of medicinal chemicals, has been prepared by Professor H. V. Arny, dean of the College of Pharmacy, Columbia University, and E. L. Newcomb, secretary of the National Wholesale Druggists Association. The map, in five colors, represents all countries from the Panama Canal Zone to Hudson Bay. Names of ores, minerals, chemicals and elements appear approximately at the point of origin. Countries, states and provinces are shown in yellow; oceans and lakes in blue; political boundaries and important cities in red; mountains in sepia, and rivers and most type matter in black. In the border are photographs and sketches of mining operations and chemical plants.

ADDITIONAL canyons were on January 5 added to the Bryce Canyon National Park, in southwestern Utah, by the proclamation signed by the President, upon the joint recommendation of the Secretary of the Interior and the Secretary of Agriculture. The park, as established in 1928, contained the remarkable Bryce Canyon, a horseshoe-shaped amphitheater cut by erosion into one of Utah's colorful plateaus and filled to the brim with a myriad of fantastically carved figures. The original boundaries, however, did not take in some adjoining canyon country needed to complete the park. Congress, realizing this, authorized the president to add additional lands, and the recently promulgated proclamation increases the park area from 14,480 to 30,560 acres. The newly-acquired lands were transferred from the Powell National Forest. The addition ranks in scenic grandeur with that portion included in the original park and includes a great crescent of eroded area in the Pink Cliffs with an air-line distance between tips of eight miles which gives an incomparable display of color. It has been likened to a giant rainbow fallen over on its side. From one elevated point in the newly added territory there is a circle of unobstructed vision of at least 320 degrees. From it on a clear day mountain ranges in the five states of Utah, Arizona, Colorado, New Mexico and Nevada may be seen. In this view, looking from southwest to southeast, the foreground is the magnificently eroded, brilliantly-colored area breaking into the Colorado River.

THE University of Florida, under the auspices of the committee of university publications, has inaugurated the issuing of a series of research monographs, under the general heading of Biological Science Series, Physical Science Series, etc., in which research work will be published from time to time by the university. The first of these monographs to appear was published May, 1930, under the title "A Contribution to the Knowledge of Florida Odonata" by Dr. C. Francis Byers. Other works are in progress. The University of Florida publications are offered in exchange for the publications of learned societies and institutions, universities and libraries.

THE annual report of the Science Museum, South Kensington, issued by the Board of Education, records the visit in 1929 of 1,061,754 members of the public, an increase of 161,700 over the figures for 1928. In August, 1929, the monthly total reached the record number of 144,655, while the total number

for the first six months of the present year has been 100,000 above that of 1929. The attraction of the museum (especially the working models) to children is noted, and the purpose of a special children's gallery or galleries set forward. The advisory committee comment gratefully upon the support received from industrial firms, institutions and private individuals in the form of gifts and loans, which have totalled 1,150, apart from three exhibitions. Willingness to offer objects of historical worth and interest to the museum maintains the collections, it is observed, at a trifling cost to the state. The need for the center block of new buildings is described as urgent, since it is space which is lacking to show current practice in the various collections of the museum, rather than willingness to lend. The lectures given normally by guide-lecturers were attended by 20,845 persons, compared with 10,600 in 1928. Special lectures were given to 3,851 persons, composing 155 parties, and 7,000 persons also visited the museum in parties under their own arrangements. The work of extending the library periodical collections has been extended, and both periodicals and books have been lent in increasing numbers.

DISCUSSION

THE BARRINGER METEORITE

I was much interested in Professor Fairchild's article, in Science for November 7, 1930, on the "Nature and Fate of the Meteor Crater Bolide." Especially was my attention attracted because he presents therein a completely new conception of the extra-terrestrial body that made the crater. He visualizes it as a single, stony meteorite, containing nodules or segregations of metallic nickel-iron; further, he conceives of the stony part (the major part) of the body having been totally destroyed by the impact and by subsequent weathering, leaving only the minor iron nodules, of which many representatives have been found.

The article, while extremely interesting, is not convincing in its proof of the above hypothesis. May I call attention to some of the reasons why my brothers and I have not been persuaded by it to alter our conception (which was my father's) of the body? That theory visualized the body as a compact swarm of nickel-iron meteorites, containing in all probability no stony individuals whatever. Professor Fairchild appears to ignore this theory, but raises several objections to the bolide's having been a solid spheroidal mass of iron 400 feet or so in diameter. Such a body would certainly not fulfil some of the conditions found at the crater, and the idea has not been seriously entertained by us.

Many of the iron individuals, or parts of individuals, of the swarm contained sufficient chlorine to cause rapid oxidation on exposure to ordinary atmospheric conditions. Those that had been so exposed before the discovery of the crater were promptly converted to the hydrated oxides of iron and nickel, giving rise to the material known as "iron shale." But quite a number of others, dug up since the discovery of the crater, were found to have been so well protected by the rock flour of crushed sandstone grains from the Coconino that oxidation had made little or no headway in them. Upon exposure to the air they oxidized rapidly, some of them going entirely to oxide in a year or two. Others, of course, have been preserved in paraffin. Still others exhibited unoxidizable nuclei, which stayed metallic and bright even after years of exposure.

From this it is seen that burial in the rock flour around the crater was a nearly perfect protection from all forms of erosion, for of course no frictional erosion could have taken place without breaking the air-seal and allowing penetration of oxygen. Now a great many iron meteorites have been found in the silica by trenches and shafts. But not a single stony meteorite, or a single piece of rock in any way foreign to the normal geology of the region, has so far been discovered. If the original mass had consisted largely, or even partly, of stone, and if any stone had survived the impact, some of it would without question have been preserved in the ejected débris.

To this argument Professor Fairchild replies that all the stone was destroyed at the instant of impact, leaving only the metallic nuclei broken entirely free of their matrix. This means that not even a minute chip or fragment of stone could have survived, or remained adhering to the iron, for some of it would otherwise have been found. Such complete destruction is hardly conceivable. Meteoric stone is usually of the nature of a dense crystalline igneous rock, certainly harder and more resistant than the soft Coconino sandstone, and probably just as tough as the Kaibab limestone. Yet great masses of the Kaibab escaped the pulverization supposed to have been meted out to the stony bolide, and even boulders of the Coconino were thrown out of the hole at the moment of impact without great damage to themselves. That part of the Coconino which was in immediate contact with the impinging mass should have been even more seriously affected than the mass itself. Yet

we find pieces of that sandstone close enough to have been stained by nickel-iron vapors, and liquefied by the friction of the mass itself, but still clearly recognizable as products of the Coconino sandstone. Had there been any appreciable amount of meteoric stone involved in the impact it would seem impossible that evidence of it should not have been found.

I have elsewhere[1] summed up the reasons for believing the impacting mass to have been a compact cluster of millions of small, rounded individuals, rather than a single mass of iron (or stone) or a single large mass accompanied by a few satellites. This conception of the body coincides with the accepted belief as to the nature of comets. One of the reasons for this conception is that most, if not all, of the Canyon Diablo irons, when in their original condition (*i.e.*, when not acted upon by terrestrial erosion) are of a rounded or oval outline. This is explained by the long-continued attrition between individuals of the clusters, attrition that may have been very slow, but that had millions of years in which to accomplish its results. If, then, the cluster had contained at its inception any appreciable number of stony individuals, they would have been subjected to exactly the same process as that which takes place in a ball mill; that is, they would have been chipped and shattered to total disintegration long before the iron members had been worn away. The dust they became would have been blown away from the comet by the pressure of light if the comet had ever come near the sun; if not, it would at least have been filtered out of the swarm at the first touch of the earth's atmosphere.

Professor Fairchild mentions the pitting of the typical Canyon Diablo irons, ascribing it (and I think rightly) to the removal of some enclosing matrix from around the unoxidizable iron. But this matrix he believes, from no evidence that I know of, to have been stone. There is strong evidence, on the other hand, that the matrix was not stone but the oxidizable variety of nickel-iron, for a good many of the pittings are partially filled with iron oxides, firm in texture and adhering closely to the iron. Also, as I have mentioned above, some of the oxidizable but metallic individuals preserved in the rock flour show unoxidizable nuclei. Here is clear evidence that the matrix which originally enclosed the Canyon Diablo irons was chlorine-bearing iron. There is no evidence to indicate it to have been stone.

The rounded shape of the original irons (for all the fragments found preserved in the rock flour were rounded) also argues against their having been inclusions in a large mass of stone. Many stony meteorites exhibiting iron inclusions are known, but those inclusions show no evidence of rounding, being on the contrary of irregular, angular shapes, filling spaces between crystals or chondrules of the enclosing matrix, or ramifying through the rock as irregular veinlets. Why should a large hypothetical siderolite exhibit such a totally different structure from the known small ones?

[1] *Scientific American*, July, August, September, 1927.

One stony meteorite was found at the crater, or rather at a distance of a mile or so from the rim. This is mentioned in my father's paper[2] of 1909, and part of it is now in the Meteor Crater collection in the Guyot Museum at Princeton. It was distinctly an individual piece, hardly to be thought of as a chip from a larger mass, and had markedly rounded outlines. As is pointed out in my father's paper, there is strong reason for believing that this was a separate and later fall than the Meteor Crater swarm.

Interesting as Professor Fairchild's conception of the Barringer meteorite is, he has presented no new evidence in support of that conception, and his conclusions from the old evidence do not warrant, to my mind, a change from the more accepted picture of the comet. My father's visualization of the celestial intruder, as a cluster of small rounded iron meteorites, containing in all probability no stony members or parts, still has all the evidence in its favor. But, though we differ from Professor Fairchild in this particular conclusion, I am deeply sensible of his long and helpful interest in the question, and of his frequent and sturdy assistance in the problems connected with it.

D. MOREAU BARRINGER, JR.
HAVERFORD, PENNSYLVANIA

CONCERNING THE RATE OF FORMATION OF STALACTITES

DURING the past summer I visited old Fort Pickens, on the west end of Santa Rosa Island, opposite Pensacola, Florida. In prowling around one of the dismantled structures, I came upon a room the ceiling of which held a number of stalactites. Considerable stalagmitic material also covered the floor. This unusual occurrence of deposits aroused my curiosity, as I thought they might throw some light on the rate of deposition of certain cave deposits.

The room where the stalactites were found was made of brick, laid in lime mortar. Both the walls and the roof were four or five feet thick. The roof was somewhat overgrown with vegetation growing from loose earthy material covering the brick. There were ample openings in the walls for a free circulation of air, yet not situated so as to allow violent winds to strike the interior. The conditions seemed quite similar to those of a limestone cave, as far as the formation of stalactites was concerned.

[2] "Meteor Crater," by D. M. Barringer, read before the National Academy of Sciences, November 16, 1909.

The largest of the stalactites were about the size of a lead pencil and about 10 inches long. All were quite fragile.

As to the time required for these depositions no definite statement can be made. The fort was in use during the Civil War, and it is likely that the roof remained in fair condition for thirty years longer. The impression received was that the rate of deposition had been much greater than is commonly thought to be the case in the growth of limestone cave deposits. It is thought that the stalactites had not very recently been disturbed, as the floor deposits were fairly commensurate with the amount of material still hanging to the ceiling. The rate of deposition may have been an inch a year. And the entire deposit came from the meager supply of limy material contained in the mortar of the brick roof.

R. W. ELLIS

UNIVERSITY OF NEW MEXICO

THE LANGUAGE OF CLERGYMEN

I HAVE read the article entitled, "The Language of Scientists," by the Reverend George W. Lay, with a great deal of pleasure. Some of the mispronunciations to which he calls attention are really delightful. Certainly every scientist should be meticulous in the use of scientific terminology. But I wonder if it is not equally important for theological scientists to be somewhat careful of the structure of sentences. In Mr. Lay's amusing castigation of his fellow members of the Association for the Advancement of Science, I see this amazing statement: "An example of ignorance or carelessness appeared in an important paper by an eminent scientist that was published in SCIENCE." I want to congratulate the publisher who undertook so stupendous a task as that. We have all heard of books that are published, but this is the first time that I, for one, have ever heard of publishing an eminent scientist. Later in his article, Mr. Lay writes: "These words are practically always derived from the Latin or the Greek . . . ." Does he mean that they are *usually* so derived? Still later, the supercritical (or is it hypercritical) Mr. Lay gives us this charming bit of English: "Attention has been called recently to two examples of unscientific confusion in the meaning of words." Perhaps Mr. Lay would be good enough to tell us what *scientific* confusion would be like. One more delightful bit of English meets us near the end of his article. He writes: "Scientists can not even trust each other." Are there, then, but two scientists who are thus antagonistic? Perhaps all scientists distrust *one another*. I have no doubt that Mr. Lay is quite correct in all his pronunciations, but a good rhetoric would tell him that there is as great a danger in misplaced phrases and misused words as in misplaced accents. If we are to carry culture into the laboratory, by all means let us expand the meaning of the word "culture" to include correct sentence structure.

THEODORE W. DARNELL

NEW YORK, N. Y.

"THE Language of Scientists" was certainly worth publishing. However, it suggests to me two questions. Mr. Lay speaks of a "co-ed graduate student." Are all participants in coeducation female?

He states later that one micromicron is a thousand times greater than another. Is it possible that he meant "a thousand times as great as"? Or, if you will, "999 times greater than"?

EDWARD S. ALLEN

BABYLONIAN MATHEMATICS

IN SCIENCE for December 12, 1930, page 601, Professor G. A. Miller writes: "The Babylonian mathematics is of special interest in view of the fact that our division of the circle into 360 parts called degrees, and our division of the degree and the hour into 60 parts called minutes and of the minute into 60 parts called seconds can be traced back thereto." May I suggest that nothing would be of greater interest to readers of SCIENCE than a presentation of references to *sources* where these various statements may be checked? Cantor makes no such claim, nor does he, in his references to Babylonian geometry, give adequate references to sources to check even the statement he does make: "for a certainty we have the division of a circle into 6 parts, then into 360 degrees." Heath reproduces no such statement. Tropfke in the third edition (1930) of Volume 1 of his history does not furnish proof of Professor Miller's claims. In 1928 Thureau-Dangin argued merely that the division of a circle into 360 parts was natural, but that further sexagesimal division was unnatural. During the past year I have given in SCIENCE[1] some references suggesting the difficulty, in the present state of our knowledge, of arriving at any definite conclusion in this regard.

R. C. ARCHIBALD

BROWN UNIVERSITY

DECEMBER 13, 1930

AN ENGINEER IN AUTHORITY

MOST scientific men were delighted when for the first time since George Washington an engineer be-

[1] SCIENCE, 71, 117–118, January 31, 1930; 71, 342, March 28, 1930. Many more detailed references are given in my "Bibliography of Egyptian and Babylonian Mathematics" in Chace's edition of the Rhind Mathematical Papyrus, 1927 and 1929.

came President of the United States. It is, however, said that Mr. Hoover, as a member of the cabinets of Mr. Harding and Mr. Coolidge, did not support the scientific work under his charge, and there seems to be no evidence since he has climbed to the presidency that he realizes the dependence of our civilization on scientific research and its applications.

As secretary of commerce Mr. Hoover indeed appointed a commission on highway safety, but he allowed the members to pay their own traveling expenses and took no notice of them, though he managed to have it called in the extensive newspaper publicity the "Hoover Commission."

Every president in recent years has welcomed to Washington the members of the National Academy of Sciences, which is the official scientific adviser of the government and of which President Hoover is perhaps the only member elected for reasons other than eminence in scientific research. It is said that at receptions at the White House Mr. Roosevelt and Mr. Wilson were able to greet by name a considerable percentage of the members. President Hoover apparently has not noticed the existence of the academy.

It is understood that President Hoover was officially invited to address the recent Cleveland meeting of the American Association for the Advancement of Science and the national societies devoted to the social and economic sciences, meeting together for the first time, but refused, though he could have spoken by radio from Washington. He has been more obliging in other instances, as witness the following editorial article from the *Journal* of the American Medical Association:

THE PRESIDENTIAL FINGER SLIPS

Norman Baker, of Muscatine, Iowa, who claims to treat successfully cancer, goiter, varicose veins and other diseases by some secret preparations, who uses his radio station to sell cigars and get patients, who attacks most of the reputable educational institutions and scientific organizations of his state and of the nation with billingsgate and vilification, found it necessary to start a newspaper to spread his views because the reputable press of his state exposed his quackery. By some of the strange influences known only to politicians, President Herbert Hoover was induced to apply to a pushbutton in Washington the presidential digit, thereby giving to the presses in Muscatine the electrical juice necessary to induce motion, whereby inked rollers applied to paper aided still further the dissemination of Baker's notions and nostrums. As an engineering feat, the demonstration must have given joy to the presidential cerebrum. As a demonstration of presidential judgment and a sense of the fitness of things, it gave acute pain to the press, the physicians and most of the people of Iowa. Somewhere, somehow, some secretary succeeded in precipitating the President of the United States into a situation that awaits explanations.

The writer asks that the publication of his name be omitted, for while it is improbable, though highly desirable, that President Hoover should read this communication, it might come to the attention of some member of his kitchen cabinet, and if so there would be no chance of appointment to a vacancy that may occur on the Federal Power Commission.

AN 'UMBLE SCIENTIST

[It need scarcely be said that a journal is not responsible for opinions expressed by contributors, least of all in the correspondence columns. It is, however, responsible for the acceptance of contributions, and this anonymous criticism of the President has been printed with some hesitation. It seems, however, that the relations of officers of the government to science should be freely discussed in a scientific journal, and that there may be good reasons, especially for those in the federal service, to withhold their names. SCIENCE will welcome communications describing Mr. Hoover's contributions to engineering and his support of science before and since his elevation to the presidency.—EDITOR.]

ANTI-EVOLUTION LAWS

AN effort should be made, this winter, in every state, to secure by legislative enactment or vote of the people, a law prohibiting the teaching of the brute origin of man in tax-supported schools and colleges, since the false "science" of evolution is the chief support of infidelity and atheism.

I shall be glad to send free a copy of my "Evolution Disproved" by 50 convincing scientific arguments, to all members of committees considering such bills, and will send a copy free to 5000 lawmakers, if given $1000 (one-fifth of price) which I shall also donate to missions, doubling all gifts at my cost.

Will you kindly insert this notice for the sake of the truth and the protection of the youth?

REVEREND W. A. WILLIAMS

CAMDEN, N. J.

SPECIAL CORRESPONDENCE

EXHIBITION ON THE SCIENCE AND ART OF COLOR

COLORS have come to play so important a part in modern life that this third decade of the twentieth century promises to be known as the "Age of Color," according to Professor Charles R. Richards, of the Museum of Science and Industry of New York, who has just announced the holding of an "Exhibition on

the Science and Art of Color" to be given at the museum's headquarters in the *Daily News* Building at 220 East 42nd Street, from January 20 to March 15.

"The exhibition will be the first comprehensive effort yet made to indicate the use and future possibilities of color in virtually all departments of modern life and will bring to the public a better understanding of both the scientific and artistic aspects of color."

Many of the latest discoveries in the color fields, never before made generally known to the public, such as photography of ranges of color invisible to the human eye and hitherto declared "unphotographable," and machines which may ultimately displace the erratic color sense of the human eye, will be on display at the exhibition.

The exhibition will be held in collaboration with leading American scientists, artists, technicians, engineers and educators and will be open daily without charge, from 10 A. M. to 5 P. M. Exhibits will range from colored kitchen utensils and other articles in the home, to clothes, decoration, reading material, food products, color in transportation, manufacturing and industrial processes, and give glimpses of the kaleidescopic cities of the next century.

In addition to numerous exhibits of color arranged by the museum itself, more than two hundred outstanding scientific, industrial and business organizations will make displays. Individual exhibits will number in the hundreds, ranging from the scientist's spectroscope and intricate color producing machinery to colored articles in daily use.

A distinctive feature of the exhibition will be an unusual arrangement of the exhibits in six major groups, permitting the layman as well as the expert to follow in logical progression from the initial group illustrating the nature of color on to groups illustrating color production, color as seen by the human eye, the measurement and specification of color, examples of color materials, and concluding with exhibits of color applications.

Many exhibits will be visitor operated. Switches and levers will permit the visitor to make his own demonstrations. A color printing press will be in actual operation, and daily demonstrations of instruments and apparatus will be given. Guides will explain many of the more complicated scientific items, and plans have been made for a series of lectures during the course of the exhibition by well-known physicists, chemists, psychologists, artists, designers, illustrators and others in the various fields of color.

"Because of the profound effects which color and its wise use may contribute to our lives, and the general appeal to all which color makes, the museum has undertaken to demonstrate to the public the great scientific and artistic advances recently made," Professor Richards stated. "For the first time, color will be presented not only from any one standpoint in a single field, but from the inclusive standpoints of the scientist, the artist, the psychologist and the technician, and an endeavor made to correlate them. The exhibition will provide an opportunity for the general public to view concrete examples of the amazing range and diversity of color uses, and to see color processes rarely available outside the walls of laboratories and in complicated technical industries."

In asserting that we are probably on the threshold of a new era in the use of color, Professor Richards voiced the opinion that "this third decade of the twentieth century might be characterized by future generations as the real beginning of the age of color."

Cooperating with the museum in the exhibition are included the following: Arthur S. Allen, color consultant; Dr. George D. Beal, Mellon Institute; Charles Bittinger, artist; Carl Foss, International Printing Ink Co.; Dr. H. P. Gage, Corning Glass Works; L. A. Jones, Eastman Kodak Company; Dr. M. Luckiesh, General Electric Company; Paul M. Rea, National Lead Company; A. L. Powell, General Electric Company; Dr. H. H. Sheldon, New York University, and Dr. J. L. Stair, Curtis Lighting, Inc.; Dr. E. E. Free, Dr. H. H. Howe, Dr. C. E. K. Mees, Eastman Kodak Company; A. E. O. Munsell, A. J. Powers, Dr. R. R. Rose, E. I. duPont de Nemours and Company; Dr. G. W. Thompson, National Lead Company; Dr. Maximilian Toch, Dr. L. T. Troland, Technicolor Motion Picture Corporation, and Dr. E. R. Weidlein, Mellon Institute.

Among the exhibitors will be: American Bank Note Company, Bakelite Corporation, Bausch and Lomb Optical Company, U. S. Bureau of Agricultural Economics, U. S. Bureau of Standards, Cheney Brothers, Claude Neon Lights Company, Columbia University, Consolidated Gas Company, Crane and Company, Curtis Lighting, Inc., E. I. duPont de Nemours and Company, Eastman Kodak Company, General Electric Company, Fisher Bodies Corporation, Norman Bel Geddes, Grasselli Chemical Company, Johns Mansville Company, Lord and Taylor, R. H. Macy and Company, Mellon Institute of Industrial Research, Associated Munsell Companies, National Lead Company, New Jersey Zinc Company, Baltimore and Ohio Railroad, New York Telephone Company; Remington-Rand Company, Sherwin-Williams Company, Shubert Theater, Stehli Silk Corporation, Strathmore Paper Company, Technicolor Motion Pictures Company, Warner Research Laboratories, Westinghouse Lamp Company, and Carl Zeiss, Incorporated.

B.

SCIENTIFIC BOOKS

The Mysterious Universe. By SIR JAMES JEANS. ix + 154 pp. Cambridge University Press, 1930. 3*s* 6d.

To those who have read Sir James Jeans's "Universe Around Us," his latest volume, "The Mysterious Universe," will prove an appropriate supplement. As the earlier volume was largely descriptive and astronomically informative, the latest book from his pen is largely philosophical and is a fitting interpreter to the facts presented in the earlier publication.

As explained in the foreword, the book is an amplification of the subject-matter presented in the Rede Lecture, delivered at the University of Cambridge in October, 1930.

In the opening chapter on "The Dying Sun," the author gives us a picture of a decadent future with all the pessimism of classical thermodynamics.

With a brisk transition, however, the reader meets in chapter two the "New World of Modern Physics." Here the revolutionary changes in fundamental concepts considered inviolate a generation ago give a far different picture of the universe than the mechanical conception of the engineer scientists of the Kelvin and Maxwell era.

In kinetoscopic fashion, he traces the metamorphosis of the radiation concepts from the undulatory theory of Huygens and Thomas Young, through the quantum theory of Planck to Schroedinger's wave-mechanics and Heisenberg's principle of indeterminism.

A chapter on relativity follows, with remarks on the astronomical consequences of the Einstein and DeSitter conception of space and time. The non-astronomical reader may be somewhat confused in the discussion of the "reddening of stars," where change in the wave-lengths of the spectral lines involved, due to various causes, is the real issue.

In chapter three, Jeans describes the significance of modern physical theories and stellar evolution leading to the startling concepts of the annihilation of matter through radiation. The possible significance of cosmic rays in this connection, and the hypothesis of Millikan that interstellar space sees the recreation of matter through absorption of cosmic radiation is discussed quite uncolored by the author's own views, although he thinks the probabilities are against such an hypothesis.

Chapter four, on "Relativity and the Ether," recounts the observational evidence at the basis of the theories of relativity. It is, perhaps, not surprising that Jeans makes no mention of the results of D. C. Miller in repeating the Michelson and Morley experiment, but one is a bit surprised to infer from the reading that the experiment was first carried on by Michelson and Morley at the University of Chicago instead of at the laboratory of the Case School in Cleveland, at which Miller's subsequent repetitions were performed.

From relativity the author progresses "Into Deep Waters," the title of chapter five. Here he pursues a philosophical and mathematical inquiry bordering on metaphysics. One sees in this volume a philosophy convening toward much the same end as has marked the recent writings of Eddington. Perhaps the most significant statement of Jeans's evaluation of the trend of modern physical science is to be found in the final paragraphs of the volume.

> To-day there is a wide measure of agreement, approaching almost to unanimity, that the stream of knowledge is heading towards a non-mechanical reality; the universe begins to look more like a great thought than like a great machine. . . . And with this reflection before us, we may well conclude by adding, what might well have been interlined into every paragraph, that everything that has been said, and every conclusion that has been tentatively put forward, is quite frankly speculative and uncertain. We have tried to discuss whether present-day science has anything to say on certain difficult questions, which are, perhaps, set for ever beyond the reach of human understanding. We can not claim to have discerned more than a very faint glimmer of light at the best; perhaps it was wholly illusory, for certainly we had to strain our eyes very hard to see anything at all. So that our main contention can hardly be that the science of to-day has a pronouncement to make, perhaps it ought rather to be that science should leave off making pronouncements: the river of knowledge has too often turned back on itself.

HARLAN T. STETSON
THE PERKINS OBSERVATORY

Artificial Sunlight. By M. LUCKIESH. 254 pp. Illustrated. D. Van Nostrand Company, Inc., New York.

THIS book, like most of this author's works, carries forward a definite theme supported by concise and digested data to a seemingly indisputable conclusion, and this makes the book useful to those interested in illumination and health. Likewise, the book is characteristic in that the author's naturalistic philosophy is a premise and a safeguard in the development.

Perhaps this thread may be epitomized by saying that, since the human race has been able to survive and thrive through countless generations with sunlight, sunlight therefore must have in it the necessary elements of radiation to support well-being and efficiency. Just as, although nature originally provided hair on the body and perspiration as protection from cold and heat, man by scientific means and otherwise learned to use clothing, shelter and artificial heating to supplement what nature provided, so, while nature has been very successful, a scientific analysis should enable us to increase the efficiency of society by artificial sunlight. This phase of the presentation should make the book interesting reading to the philosopher, the student of nature and all those who have not a deadened intellectual curiosity.

The opening sentences are most illuminating. "Nature is beneficent—life-giving—but also ruthlessly destructive. Its eternal shower of blessings has not effaced or even dimmed the edict that only the fit shall survive." In the first chaper on "A New Era of Lighting" is shown how man's striving to supply the elements of sunlight in his machine age living has resulted in the development of lamps that supply the requisite character of illumination and the needed ultra-violet light.

In the chapter on the sun's beneficence is given not only an array of historic facts and modern scientific data supporting the theses that sunlight, generally speaking, supports good health, but the argument is made more impressive by a chart showing the relation between the death-rate in the different months of the year and the hours of sunshine corresponding thereto. The chapter on solar radiation is essentially a digest of some of the leading workers in this field. On the basis of these data he concludes that artificial sunlight must be developed more or less independently of natural sunlight, but he does not imply that all the elements known to be useful should not be preserved.

Dr. Luckiesh has supplied the underlying data for designing lighting installations, of artificial sunlight with the various sources and filters available. Although considerable work remains to be done in conserving the requisite ultra-violet component, nevertheless the practical application is already within engineering reach.

Beginning with the fifth chapter, the book consists very largely of the author's data. It is very interesting to note that the carrying out of the problem requires the development of paints for ceilings so that indirect lighting can be used, but where this is not feasible it is always possible to resort to special fixtures, of which many have been designed and several have been built.

F. C. BROWN

MUSEUM OF SCIENCE AND INDUSTRY,
NEW YORK

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW MICRO-MANIPULATOR

Is there a worker with a micro-manipulator who does not wish that his instrument possessed more than merely smooth and exact control in three dimensions; whose impatience has not suggested improvements to facilitate his operations? Suggestions gathered from various laboratories go far to define the ideal manipulator, which should conceivably have the following characteristics:

1. Simple and quick gross adjustments to the microscope, giving a wide range of orientation.

2. Means for immediate return of the point to its operating position after withdrawal of the micromanipulator for the setting or changing of the moist chamber, etc.

3. Grouped controlling handles which permit instant selection and actuation by the fingers of one hand without distraction of attention.

4. Coordination of the motion of each controlling handle with the resultant motion of the operating point, producing, as observed under the microscope, "natural" or expected movement.

5. Complete bilateral symmetry in double instruments through a right- and left-hand arrangement of controls.

6. Identical direction of the motion of each pair of corresponding controls in double instruments to secure identical movements of the respective operating points.

7. Compactness and directness of action, even in combination with a micro-injector, which will permit inclination of the manipulator to an acute angle with the optical axis of the microscope for operations on tissues and organs *in situ* in living animals.

8. Rugged and wearproof moving and bearing parts, so that proper use will not limit the life of the instrument.

An original solution of the mechanical problems involved in micro-operations is offered in the design of a micro-manipulator by the writer, here first publicly described. The special features of this design are covered in applications for patents now pending.

A diagrammatic general view of a double manipulator in relation to a microscope is shown in Fig. 1.

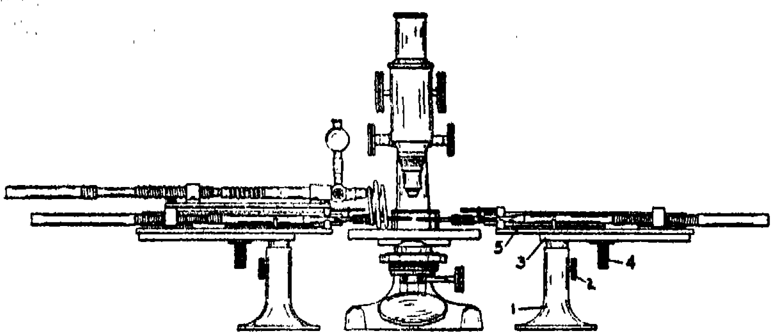


FIG. 1.

To the right-hand instrument is attached a removable micro-injector, applicable to either side. The manipulator is supported on a hollow pedestal 1 which receives the stem of a bracket 3 and holds it at any level by means of the clamp screw 2. The bracket has a broad top with a 4-inch slot through which a screw from the base 5 of the manipulator freely slides, but may be clamped as desired by the nut 4.

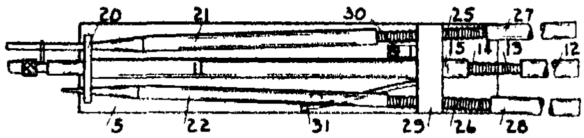


FIG. 2.

The manipulator itself, which rests upon the shelf of the bracket, is best shown in Fig. 2.

The main axis, Fig. 3, is a tubular casing 11 which

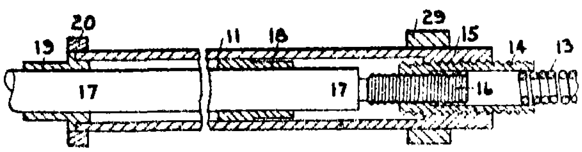


FIG. 3.

encloses the thrust mechanism and guides the thrust rod 17, whose extension carries the operating point. To avoid the serious disadvantages of an extremely fine screw for the control of the thrust motion of the point, a differential screw system has been used (14, 15, 16) which is as direct acting, but permits the use of strong and durable screw threads, *viz.*, 32 and 40 to the inch.

The system is actuated by the handle 12, acting through the spring wire coil 13 upon the hollow screw 14. As the screw in one complete rotation advances one thirty-second of an inch into its nut 15, the screw 16 is drawn back one fortieth of an inch into its nut in the inner end of the screw 14. The advance of the rod 17 and consequently of the operating point is, therefore, their difference, which is 0.00625 inch or 0.156 mm. This is equivalent to one rotation of a single acting screw with 160 threads to the inch (6.4 to the mm) and is amply fine for work under the highest usable power. The actuating handle is small and, therefore, may be rapidly rotated between the thumb and finger for quickly adjusting the operating point.

The rod 17 is supported by close-fitting spring sleeves attached to the guides 18 and 19, which prevent all side motion and thus insure a pure thrust of the operating point. The thrust rod terminates in a tapered stud on which may be slipped corresponding hollow couplings (B. D. subcu needles) carrying operating points.

The motions of the operating point laterally and vertically are produced by cam or wedge action, as shown in Figs. 2 and 4. The end of the tubular axis

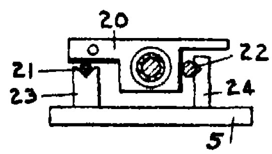


FIG. 4.

11 carries the cross-plate 20 with horizontal and vertical V bearing edges, which are held by appropriate spring action firmly against the cone extensions of rods 21 and 22 lying in their corresponding notches in pins 23 and 24. The cone-ended rods are flexibly attached to the screws 25 and 26, which are threaded through the cross-bar 29.

It is evident that when screw 25 is rotated by its handle 27 to advance rod 21, the cone 21 will push under the horizontal V edge of plate 20 to lift it. It, thereby, raises the operating point. Similar rotation of screw 26 will obviously throw the operating point sidewise.

These two motions, vertical and horizontal, are centered at the cross-bar 29 by the method of its attachment to the base 5, as shown in Figs. 5 and 6. The cross-bar rests on two balls and thus is free to move horizontally and, by tipping, vertically about the horizontal axis connecting the two balls. The center for the horizontal motion lies in the screw pin 30, which

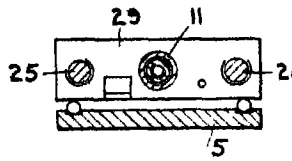


FIG. 5.

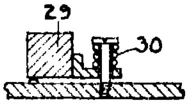


FIG. 6.

passes through a hole in a short offset from the cross-bar 29. This screw pin is surrounded by a coil spring which, pressing strongly on the offset, throws the cross-plate 20 down upon the cone 21 and its notched supporting post 23 and at the same time firmly seats cross-bar 29 upon its supporting balls in their cups in base 5.

The lateral control is secured similarly by the elastic pressure of spring 31, which forces plate 20 and the intervening cone 22 horizontally against the side notch of post 24. These springs insure that there will be no backlash in the response of the operating point to the movements of the cones.

The cones are integral with their steel rods and are hardened, ground, and polished to a true form to insure perfectly uniform and steady control. They taper 0.157 inch per inch. The screws have 32 threads to the inch; therefore, one turn of each screw causes a movement of the operating point of 0.155 mm laterally or vertically.

The range of motion of the point in fine adjustment is 6 mm in each of the three dimensions, which gives 3 mm each way from the midpoint at which the controlling screws should be kept. Since the bracket stem and base clamps permit easy and quick adjustment to less than 1 mm, this range is ample.

The use of a setting guide to locate the optical axis of the microscope and the height of the cover-glass of the moist chamber makes a preliminary setting of the point very accurate and simple.

The flexible connections between the screws and the cone rods are necessary, since the rods vary their alignment to the screws and thus would bind or be thrown out of their notches if made integral. They are used between the handles and screws to avoid adventitious movement of the whole apparatus when the handles are actuated. By their use, the apparatus can be made much lighter and less cumbersome without sacrificing essential rigidity.

To coordinate the handle motions with those of the apparent operating point, the right manipulator has all the adjusting screws—14, 16, 25 and 26—with left-hand threads. As a result, when the upper surfaces of the controlling handles are rotated away from the operator (given a right turn), 28 moves the apparent point away, 12 moves it to the left, and 27 lowers it. In the left instrument, on the contrary, to produce the same results only the differential screws of the thrust have left threads, the others having right.

The two instruments are arranged in bilateral symmetry: both have the lateral control on the near side of the thrust, the vertical control on the far side. The rotations of the corresponding controlling handles are, moreover, identical to produce the same direction of movement of the two operating points.

The selection of the proper handles and the conscious coordination of their movements to the corresponding movements of the apparent operating point or points is thus made so essentially simple, even in the double manipulator, as to become quickly automatic. This ease of use is increased by the open construction of the mechanism, its simplicity of design, and its directness of action. That any one familiar with a microscope can understand and use the instrument at once, has been thoroughly demonstrated.

The manipulator is designed to receive a special micro-injector-aspirator in a position permitting its operating handle to be included in the group of manipulator controls (Fig. 1). Convenience and rapidity of operation are thus insured to this line of work. A detailed description of this injector will be given later.

The combined manipulator and injector may be inclined by means of a hinged bracket support in place of the right-angled one shown in Fig. 1, so as to reach into a cavity for operation *in situ* in animals.

The manipulator is designed to operate either under or over a cover-glass and from either the side, front or rear of the optical axis of the microscope. For convenience, in the front and rear approaches, the shaft of the removable operating point unit is bent at right angles, thus permitting the two points of the double instrument to enter one opening of a moist chamber. The front approach is shown in Fig. 1. It is obvious that there are no changes in the relations of the controls.

By means of an attachment not shown in the figures, it is a simple matter to return the operating point to its former position in the field after sliding it away for the placing of the moist chamber, etc. By using both the point setter and the position duplicator, one can fix the point in the optical axis at the proper height, set the duplicator, slide the manipulator away, adjust the moist chamber into its position, slide the manipulator back and find the point in the optical axis ready for work. With a little additional care

it is also possible to change points with the same result.

From the above description it will be seen that the new micro-manipulator is presented as a universal instrument, adapted to micro-operation in its widest range. It is believed by its designer and by its sponsors, the Bausch and Lomb Optical Company, to have met the laboratory requirements as above outlined.

G. W. FITZ

PECONIC, L. I., N. Y.

SPECIAL ARTICLES

OVULATION, OESTRUS AND COPULATION WITH CONSEQUENT DYSTOCIA DURING PREGNANCY, IN THE MOUSE

As has been pointed out recently by Swezy and Evans[1] two cases of copulation during pregnancy were observed by Long and Evans[2] in the course of their observations on the rat. Nelson[3] also reported a case of oestrus in the rat, occurring at regular intervals during pregnancy, with copulation taking place at three of these intervals. Swezy and Evans report that the cycle of ovogenesis is not interrupted during pregnancy in the rat, for they observed the periodic appearance of mature follicles and young corpora lutea in the ovary throughout gestation, although they were not able to demonstrate the presence of ova in the oviducts.

I have recently noted a case in which ovulation occurred during pregnancy in the mouse, and furthermore, as in the case reported by Nelson, copulation occurred as was evidenced by the presence of a vaginal plug. During routine examination this mouse which was in labor was observed to be in distress. Examination showed the presence of a vaginal plug which was so firmly attached that it could not be removed by means of a forceps. The animal was observed at intervals from 8:30 A. M. until 11:00 A. M. Frequent strong muscular contractions occurred, after which she made attempts to deliver the young. She was left alone, and at 3:45 P. M. observations were again continued. At this time she was still in labor, but three young had been born. The vaginal plug was found adherent to the vulva and apparently had been forced out by the muscular contractions on the first young to be born. The placenta was attached to one of the dead newborn young, suggesting that the mother probably was too fatigued to dispose of it properly. Since vigorous, periodic labor contractions were still occurring frequently with no results, the animal was killed at 4:30 P. M., or eight hours after she was first noticed to be in labor. Six fetuses, two of which were alive, were found in the uterus. No movements were observed in the other four, which were still in loco.

Histological examination of the ovaries and oviducts showed that ovulation had occurred. One ovary contained eight young corpora lutea which were about seven hours old, according to Allen's[4] criteria for the age of corpora lutea. The distal portion of the corresponding oviduct contained eight ova. The other ovary contained three seven-hour corpora lutea, and three ova were found in the oviduct. Ovulation evidently had occurred synchronously, because the ova were clumped together and were surrounded by discus cells. Fertilization had not yet taken place, for all but two ova contained the second maturation spindle. These two appeared to be in the prophase of the second maturation division. Twenty-one mature follicles were found in one ovary and sixteen in the other, an unusually large number.

The mouse, a virgin, had been put with a male on May 14. Neither a vaginal plug nor the placental sign had been observed. Twenty-two days later a vaginal plug was found, although pregnancy had not terminated. Presumably the gestational period was of normal length, since the litter did not appear more mature than usual.

It is apparent from these things that not only did ovulation occur during pregnancy but that it was accompanied by oestrus and copulation, the influence of the corpora lutea of pregnancy being insufficient to suppress ovulation until after parturition, as is usual. The number of mature follicles in the ovary suggests the possibility of hyperactivity of the hypophysis, with consequent formation of more than the usual number of follicles, which in turn might secrete sufficient folliculin to cause oestrus to be superimposed upon pregnancy.

This case, together with that of Nelson and the observations of Swezy and Evans, suggests that superfetation may occur during pregnancy in the mouse and hence also in allied forms, provided that ovulation takes place either before the closing of the uterine lumen due to the gestational changes, or after reestablishment of the lumen, before the advent of parturition. If it occurred in the first instance, the difference in the age of the fetuses in the same litter

[1] O. Swezy and H. M. Evans, "Ovarian Changes during Pregnancy in the Rat," SCIENCE, 71 (1828): 46, January 10, 1930.

[2] J. A. Long and H. M. Evans, "The Oestrus Cycle in the Rat and its Associated Phenomena," *Memoirs of the University of California*, 6, 1922.

[3] W. O. Nelson, "Oestrus during Pregnancy," SCIENCE, 70 (1819): 453, November 8, 1929.

[4] E. Allen, "Oestrus Cycle in the Mouse," *Am. J. Anat.*, 30, 1922.

should not be more than four or five days, though it might be less, because of some variability in the length of the oestrus cycle, as well as in that of gestation. Such a course of events might explain the cases in which some of the young of the same litter are much smaller than the rest.

On the other hand, if ovulation occurred after the reestablishment of the uterine lumen, the birth of full-term young about sixteen days after the previous litter might be accounted for, though I have found no reports of such cases. However, since implantation would not occur until the fifth day, that is, until after parturition, in such cases, they could not be considered true cases of superfetation, unless the onset of pregnancy were counted from fertilization rather than from implantation.

In the cases cited by King[5] and Sumner[6] in which from twelve to fourteen days elapsed between two consecutive litters it is conceivable that the first pregnancy may have been confined to one horn of the uterus and that subsequent ovulation resulted in implantations in the other horn, a possibility which was suggested by King.

I wish to express my sincere appreciation to Dr. A. W. Meyer, to whom I am indebted for assistance and suggestions during the progress of this study.

LUCY J. WATT

DEPARTMENT OF ANATOMY,
STANFORD UNIVERSITY

[5] H. D. King, "Some Anomalies in the Gestation of the Albino Rat (*Mus Norvegicus Albinus*)," *Biol. Bul.*, 24, 1913.

[6] F. B. Sumner, "Notes on Superfetation and Deferred Fertilization among Mice," *Biol. Bul.*, 30, 1916.

DETERMINATE EVOLUTION IN THE GENUS SPIRIFER

SINCE March, 1920, the writer has engaged in a study of variation and evolution in two groups of organisms belonging to the inclusive brachiopod genus *Spirifer*. Work first was done at the Walker Museum of the University of Chicago, and from September, 1926, to September, 1928, at the University of Cincinnati, under a National Research fellowship in the biological sciences. Since the latter date, results have been correlated and a manuscript report prepared which will be published by the Wagner Free Institute of Science of Philadelphia.

The Linnaean species *Spirifer orestes* Hall and Whitfield and *S. hungerfordi* Hall comprise two widely divergent groups within the genus *Spirifer*. The former fall within the *Aperturati* of Hall and Clarke, which include the genotype, *S. striatus* (Martín); the latter are rather primitive members of the section or subgenus *Choristites* Fischer. Both are characteristic of the uppermost Devonian (Hackberry) strata of Iowa, though closely related forms (kindly loaned by Dr. C. R. Stauffer) are found in the Martin formation of Arizona.

Since the description of *Spirifer hungerfordi* by Hall,[1] and *S. orestes* by Hall and Whitfield,[2] paleontologists have recognized that these two Linneans exhibit considerable variation or speciation, but no serious published effort has been made to distinguish them. Even in our account of the Hackberry fauna,[3] Mrs. Fenton and I merely called attention to the existence of such speciation and illustrated a few examples.

This study began, therefore, with a careful taxonomic revision, little attention being given to evolution. In the *Spirifer orestes* group (here designated a *phratry*) this revision is based primarily upon the striae, nodes and pustules which form the minute ornament of the shell, since they have been found to be much more reliable than gross characters of shape, plications, sinus or fold. In the *S. hungerfordi* gens, however, the minute ornament is essentially uniform, so that gross characters must be relied upon. In consequence, there is some discrepancy between the taxonomic units determined in the two groups, those in the former being much the more precise.

Although work at first was concentrated upon pure taxonomic differentiation, it soon became evident that the taxonomic units, when arranged stratigraphically, automatically were arranged in apparently determinate evolutionary series, distinct, parallel or homeomorphic, and non-contemporaneous. The existence of such series and a provisional interpretation of them were reported in June, 1926, although not published until 1927.[4] In September, 1926, a collection of about six thousand additional specimens, with exceptionally precise data, was secured from the late Mr. C. H. Belanski. Work was begun *de novo*, even the taxonomic units previously determined being put aside. They at once reappeared, however, as did the evolutionary series; and again it was found that series based only on characters of surface (in the *Spirifer orestes* phratry) showed regularly correlated changes in form and character and number of plications. The situation may be summed up as follows.

In the *Spirifer orestes* phratry, the primitive surface ornament consists of minute, subradial to oblique ridges or striae, which are not broken and which bear neither nodes nor pustules. In every one of the divisions (gentes, subgentes, species) into which the phratry may be divided there is an apparently determinate evolution of these striae involving three or

[1] *Geol. Iowa*, 1 pt. 2: 501, pl. 4, figs. 1a–k, 1858.

[2] *Ann. Rep. N. Y. State Cab. Nat. Hist.*, 23: 237, pl. 11, figs. 16–20, 1873.

[3] "Stratig. and Fauna of the Hackberry Stage of the Upper Devonian," 1924.

[4] *Univ. Chicago Abs. of Theses*, sci. ser. 5: 223–226, 1927.

more of the following steps: (1) primitive, continuous striae; (2) constriction of the striae, occasionally accompanied by swelling, resulting in the formation of nodes; (3) further constriction of these elevations, resulting in rows of round, generally hollow pustules; (4) loss of definite arrangement in these pustules, at least marginally; (5) enlargement of these scattered pustules into short spines. These stages are accompanied by a reduction, relative or actual, in the width of the shell, a consequent increase in tumidity, a reduction in the number and strength of the plications and (generally) a marked increase in the number of growth lamellae.

The progress of evolution, especially in forms which reach stage 4 or 5, may be traced minutely in the ontogeny of the shell. Moreover, there commonly is a close relationship between the duration of a stage in the evolution of a given line and its duration in the life of an individual, as measured in the amount of shell surface on which it is evidenced.

In spite of the regularity of these trends, they are not contemporaneous. One group, in an advanced stage of pustulation, will be contemporaneous with another in which stage 2 has been reached, and a third in which striae are primitive and continuous. In every line advanced stages of evolution, both in striae and gross characters, are followed by disappearance, and disappearance also is non-contemporaneous. These facts, plus a lack of evidence of progressive environmental change, negate the theory of natural selection, while the uniformly determinate, even predictable, nature of the changes, militates against heterogenesis.

It seems, therefore, that in the *Spirifer orestes* phratry we have numerous, parallel examples of determinate or orthogenetic evolution, operating independently of the environment and resulting regularly in extinction of the lines affected. Such evolution commonly is interpreted as racial senescence, although that theory generally has involved such factors as gigantism, multiplication of structures and extreme spinescence, which are lacking in the *Spirifer orestes* phratry.

There are several lines of evidence, however, which support Child's hypothesis of racial senescence through heritable, cumulative decrease in the rate of basal metabolism as an interpretation of these evolution trends.[5] One is the minute correlation between ontogeny and phylogeny, which strongly suggests a community of cause. Another is the fact that phylogerontic members of any given line more commonly show injury than do phyloephebic ones, and have repaired those injuries much less effectively. In the latter, valves fractured during neanic growth may be so well repaired that the injury is not shown ephebically, while in the former, injuries too small to be distinguished clearly commonly distort the entire shell. Finally, phylogerontic forms seem to have been extremely susceptible to physiologic disturbance, their shells bearing abundant and pronounced growth lamellae and constrictions. These, like incapacity for repair, seem to indicate a lowered metabolism in the organisms concerned.

[5] "Senescence and Rejuvenescence," 193–194, 463–464, 1915.

Evidence gleaned from the *Spirifer hungerfordi* gens is less conclusive regarding precise trends than is that from the *S. orestes* phratry. On the other hand, it is quite as definitely negative toward theories of selection and environmental influence, since widely divergent groups develop contemporaneously in the same spots. Evidence from injury, repair and growth disturbance is virtually identical and affords the best indication that a common evolutionary process underlies the divergent trends just mentioned.

From the evidence here briefly summarized, a theory of the racial life cycle is advanced which may be stated as follows.

Stages in the life history of a race may approximate those in that of the individuals composing it, and in such cases, rest upon the same physiologic basis. Changes involved in racial *origin*, in such series, find their cause in genetic variations which increase the metabolic rate; those of differentiation and decline (racial senescence) in heritable variations which reduce that rate.

CARROLL LANE FENTON
UNIVERSITY OF BUFFALO

CHANGES OCCURRING IN STORED ALCOHOLIC PLANT EXTRACTS[1]

PHYTO-CHEMISTS have used the alcoholic preservation method for the storage of plant materials for a considerable number of years. Surprisingly small, however, is the amount of work that has been done to explain the reasons for each step, and practically nothing has been done to check the effects of such a procedure on the various constituents to be estimated. There are such statements as, "Preserved in 80 per cent. alcohol," and "Calcium carbonate added to neutralize the acidity," and theoretical considerations are found to justify such statements. As previously stated, it is very hard to find analytical data to explain the reason for these steps. It is coming to be recognized that nitrogen fractionation must be completed on water extracts. A previous paper[2] from

[1] Published with the permission of the director of the Oklahoma Agricultural Experiment Station.

[2] J. E. Webster, "Effects of Storage on Alcoholic Extracts, I. Amino Acid Changes," *Plant Phys.*, 4: 141–4, 1929.

this station has shown that under certain conditions ordinarily met with, the alpha amino nitrogen percentage decreases while in storage. Work on the factors responsible for these changes is progressing but of necessity must cover a long period of time and involve a great number of factors. Several interesting results have been secured to date, and it is felt that they are of enough importance to the field of plant chemistry to be published prior to the main body of the work which will be published at a later date.

One of the most interesting facts discovered is that the term "calcium carbonate added to neutralize the acidity" is most uncertain. Plant samples prepared in the usual manner by adding an excess of $CaCO_3$ have been found in most cases to be distinctly acid, the amount of acidity, of course, depending upon the material preserved. Approximate hydrogen ion determinations have been made on a number of solutions using the colorimetric procedure, and they have been found to range from pH 4.6 to 6.0. The following figures may be given as an example of their acidity. Five cc portions of several of these samples were brought to approximate neutrality, using N/10 NaOH.

Plant	1	4. drops N/10 NaOH
"	2	3. " " "
"	3	4. " " "
"	4	8. " " "

From these figures it is at once apparent that the acidity varies considerably, and the solution being acid even when treated with $CaCO_3$, changes may result that we did not expect on theoretical grounds. Perhaps the acidity has little, if any, bearing on carbohydrate changes in these stored extracts, but until all the conditions surrounding this point are critically examined, we must hold such determinations at least open to question. A recent publication[3] takes note of this fact and brings alcoholic solutions to a pH of 5.8 to 6.0 using tenth-normal NaOH to neutralize the acidity of the extracts. This procedure must certainly be recognized as a great advance over the addition of an excess of $CaCO_3$.

While the importance of acidity is not so apparent in the carbohydrate analyses, in the nitrogen changes it is most important, as the following figures show, at least, on the amount of ammonia present. Only one set of figures is given but they are representative. Samples were prepared and analyzed as outlined in my previous work.[2]

[3] Nightingale, Addoms and Blake, "Development and Ripening of Peaches as Correlated with Physical Characteristics, Chemical Composition, and Histological Structure of the Fruit Flesh: III. Macrochemistry," N. J. Agr. Expt. Sta. Bull. 494, 1930.

TABLE I

pH 4.2		pH 8. +	
Date	NH_3	Date	NH_3
2–27–29	2.72	2–27–29	2.14
3–12–29	2.90	3–12–29	4.60
5–22–29	4.00	5–22–29	7.89
11– 7–29	4.62	11– 7–29	8.50

Celery extract in approximately 80 per cent. alcohol. Ammonia in terms of N/50 HCl.

From Table I we see that there is a continuous increase in the amount of ammonia and that this increase is much greater in the alkaline solution. In all the solutions examined (grapes, celery, lettuce, spinach) there has been found some increase in ammonia on standing, both in acid and alkaline solutions. In some, however, the increase has been small and perhaps in samples of other materials would be negligible.

No explanation of these changes can be given until further work is completed, but on the basis of the present work it does not seem that the increase in ammonia results from a deaminization of amino acids even though we do know that the amount of alpha amino nitrogen decreases in some of these solutions.

In conclusion it seems that this question of alcoholic storage has not received the attention it should and that to make our plant analyses of value when we use this procedure a host of questions bearing on this field should be answered. This laboratory is continuing its work, but the need for some satisfactory method of preserving plant material for analyses is so pressing that it offers a ready field to the experimenter, and one that should well repay the research workers.

JAMES E. WEBSTER

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

BOOKS RECEIVED

BROOM, R. *The Origin of the Human Skeleton.* Pp. iv + 164. Witherby. 10/6.

CLIFFORD, JAMES L. *Experiments in Atomic Science for the Amateur.* Pp. 119. 44 figures. Badger.

Library of Congress. *Report of the Librarian, 1930.* Pp. xvi + 420. Government Printing Office.

MACKAYE, JAMES. *The Dynamic Universe.* Pp. xi + 308. Scribner's. $3.50.

PAYNE, CECILIA H. *The Stars of High Luminosity.* Pp. xiii + 320. Harvard Observatory Monographs. No. 3. McGraw-Hill. $3.50.

RICE, STUART A., Editor. *Methods in Social Science. A Case Book.* Pp. xiii + 822. University of Chicago Press.

VOLTERRA, VITO. *Theory of Functionals.* Pp. xiv + 226. Blackie. 25/.

WILLIAMS, SAMUEL ROBINSON. *Magnetic Phenomena.* Pp. xxii + 230. McGraw-Hill. $3.00.

SCIENCE

VOL. LXXIII — FRIDAY, JANUARY 23, 1931 — No. 1882

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

EROSION AS A FACTOR IN SOIL DETERMINATION[1]

By M. F. MILLER
UNIVERSITY OF MISSOURI

IT is common knowledge that soils may deteriorate more or less seriously under agriculture. The fundamental changes accompanying this deterioration may include such alterations as a decline in the original store of organic matter, a decrease in the amounts of total and readily available nutrients, an increase in the hydrogen-ion concentration, a modification of the biological activities, and a change in the physical properties of the soil. The extent to which erosion is responsible for such changes has been the subject of much recent speculation. Simple observation warrants the statement that under favorable conditions for erosive action, erosion may be the principal contributing factor responsible for such deterioration, while under less favorable conditions its importance may be of minor significance. There is little doubt, however, that taking the agricultural regions of the United States as a whole far too little consideration has been given to this matter.

Erosion through the action of wind or water is a natural phenomenon with which most people are familiar. The development of the existing topographic relief in any given section of the country is to a large degree the result of erosive action. It, therefore, has a great geological importance in determining the character of land surfaces. But erosion is also of importance in determining the character of both virgin and cultivated soils, and as a consequence it has a great significance to agriculture. Under nature, soil removal through erosion takes place slowly, but under agriculture, particularly a type of agriculture which makes no provision for soil preservation, such losses may be tremendously magnified.

Wind erosion, which is confined largely to semi-arid and arid regions, may under systems of grain farming

[1] Address of the retiring chairman and vice-president of Section O—Agriculture, American Association for the Advancement of Science, Cleveland, Ohio, December, 1930.

bring about great damage to crops and a degree of soil injury which sometimes results in land abandonment. Serious water erosion may also occur in semi-arid regions, although its influence is naturally most wide-spread in the humid and sub-humid sections. The discussion which follows will be confined to water erosion, particularly that of humid and sub-humid regions and largely to that of lands devoted to agriculture.

Water erosion is commonly considered as of two types, sheet erosion and gullying. Sheet erosion is that through which the soil of the immediate surface layers is removed through the flooding of heavy rains. It is this type of erosion which, under agriculture, is responsible for the largest soil losses, particularly where land is plowed and left bare for considerable lengths of time or where it is planted to intertilled crops, such as corn or cotton. Gully erosion, on the other hand, through which the soil is trenched and scarred by the action of run-off water, may occur on grass lands as well as lands under cultivation. The final effect of serious gully erosion is to cut the fields into such small tracts that a profitable agriculture, through the use of ordinary farm implements, becomes practically impossible.

The factors which determine the rate of determination of agricultural lands through erosion are; First, the amount, distribution and the torrential character of the precipitation; second, the number of days of the year when the soil is not frozen; third, the topography; fourth, the character of the soil; and fifth, the system of agriculture. Generally speaking, erosion is most severe where a large percentage of the rains are of torrential character, where the ground is frozen but a small portion of the year, if at all, where the land slopes are steep, where the soil texture is such as to be easily eroded, and where the system of agriculture is one which exposes much of the bare soil surface to surface run-off.

Observations of the losses due to the erosion of agricultural lands show these to be greatest in the soils of the Southern states, particularly those of the southern parts of the Appalachian and Piedmont regions, of the Atlantic coastal plain, of parts of the limestone regions of Kentucky and Tennessee, of the black soil belt of Texas, and of the southern parts of the corn belt. Serious losses are also taking place in parts of the range country of the West, where close pasturing has exposed the soil to the action of the torrential rains of those regions.

Trustworthy estimates of the erosion losses taking place from farm lands are difficult to make. A careful observer traveling through those areas most subject to serious erosion is struck by the tremendous damage that has resulted. Bennett states[2] that in a single county in the Southern Piedmont Region 90,000 acres of land have been permanently ruined by erosion, and 70,000 acres in another, while in many other Southern counties such ruined lands represent areas ranging from 10,000 to 30,000 acres, most of which was once under cultivation. Areas have been examined in these counties where ten or more inches of soil have been removed during 30 years of agriculture. Naturally such losses represent extreme cases rather than the average. There is no doubt, however, that over the southern half of the humid region of the United States and over a part of the northern half, erosion losses are very severe. Moreover, the damage is undoubtedly cumulative, increasing somewhat as the absorptive power of the soil for water decreases, due both to a decrease in the supply of organic matter and to a decrease in the depth of the absorptive surface layer.

Exact measurements of the erosion losses which may take place under agriculture have thus far been made in only a few places. The studies which have been made at the Missouri, North Carolina and Texas experiment stations have furnished the major part of such data. The climate, soils and systems of cropping at these three stations vary widely, as do the amounts of soil eroded under the different crops and cropping systems, yet the data give some idea of what may be expected in widely separated sections of the country.

At the Missouri station the studies have been confined largely to a Shelby loam soil with a grade of 3.68 per cent., a length of slope of 90 feet, and under a rainfall of approximately 37 inches. As an average of twelve years' measurements bare, uncropped and cultivated land has suffered an annual loss of approximately 43 tons of soil per acre. Under exactly the same conditions land cropped continuously to corn has lost approximately 20 tons per acre annually, that in continuous wheat 9 tons, that in a good crop rotation 3 tons, while land left in continuous sod lost soil at the rate of only one third of a ton annually. Under these conditions of the surface 7 inches of soil would be removed from the uncropped, cultivated land in 23 years, from the corn land in 50 years, from the wheat land in approximately 100 years, from the land in a good crop rotation in 350 years, while under sod almost 3,000 years would be required. These figures show the very great influence of the system of agriculture, particularly the cropping system, on erosion losses. Certainly the grade of 3.68 per cent. is not greater than an average for corn

[2] U. S. Department of Agriculture Circular 33.

belt soils and these data give a good idea as to what may be expected under these conditions.

Data similar to those just given are available from these same studies, showing the influence of different grades on erosion losses. As a four-year average and where the same years are compared, land in continuous corn, with a grade of 3.68 per cent., lost soil at the rate of 26 tons per acre annually. With a grade of 6 per cent. the annual acre loss was approximately 85 tons, and with a grade of 8.5 per cent. the loss was approximately 150 tons. Under the 8.5 per cent. grade on this Shelby loam soil, when planted continuously to corn, the surface soil was removed at the rate of one inch per year. The normal depth of the surface soil is approximately 9 inches so that under such conditions the subsoil would be exposed in less than one decade. It is under such conditions that sheet erosion becomes very destructive in removing the fertility which nature has taken thousands of years to accumulate in this humus-bearing layer of surface soil.

Many estimates have been made of the amounts of plant nutrients removed from the land through erosion. Some of these estimates are based on careful determinations of the elements carried in river water. An example of such an estimate is that of McHargue and Peter[3] who analyzed the material carried in solution by the Mississippi River at Baton Rouge, and calculated the annual loss from the Mississippi basin to be approximately 630,000 tons of nitrogen, 62,000 tons of phosphorus, 1,626,000 tons of potassium, and 22,446,000 tons of calcium. This, of course, does not include the nutrients carried to the Gulf in the suspended material or deposited along the course of the Mississippi and its tributaries. On the other hand, much of the mineral nutrients, particularly the lime, was probably derived from rock rather than from the soil. It is, therefore, unlikely that such estimates represent very closely the actual losses from agricultural lands.

The erosion measurements at the Missouri station include some data as to the elements contained in the eroded material. These data show an annual acre loss from the 3.68 per cent. grade under continuous corn of about 65 pounds of nitrogen, 18 pounds of phosphorus and 610 pounds of potassium. Continuous wheat allows a loss of about 30 pounds of nitrogen, 9 pounds of phosphorus and 250 pounds of potassium. Under the corn, wheat, clover rotation, however, the losses are reduced to about 18 pounds of nitrogen, 4 pounds of phosphorus and 140 pounds of potassium, while under continuous sod they reach the extremely small quantities of less than a pound of nitrogen and phosphorus, and only 4 pounds of potassium. These figures represent a single soil under southern corn belt conditions and for a short period of measurement only, yet they give a good comparison of the influences of different crops and a good crop rotation on the losses which may take place.

[3] Kentucky Experiment Station Bulletin 237.

It will be observed that the losses of nutrient elements through erosion, as compared with the losses through crops in these Missouri studies of a loam soil of 3.68 per cent. grade, depend largely on the cropping system. Under a poor cropping system of continuous grain farming the losses from the two sources, with the exception of the potassium, are about equal, but under a good cropping system the erosion losses are much less than the losses through crops. However, when land with a grade of 8.5 per cent. was studied the erosion losses were multiplied several times. It can be said, therefore, that with a moderate grade and a good cropping system in the southern corn belt, losses of soil nutrients through erosion do not compare with the losses through crops, but with steeper slopes and especially under excessive corn farming, these losses may be several times those through the crops.

The erosion measurements at the North Carolina station have been carried out on a Cecil fine sandy loam soil with a grade of 9 per cent., a length of slope of 75 feet and an average rainfall of 41 inches. A three-year average shows an annual acre loss from cultivated uncropped land of approximately 21 tons, from continuous cotton 20 tons, from continuous corn 13½ tons, and from continuous sod only .42 ton. These losses, even on a grade of 9 per cent., are somewhat less for cultivated uncropped land and for continuous corn land than from the grade of 3.68 per cent. at the Missouri station, thus emphasizing the great differences which may be expected from different soils and different types of rainfall. Both sets of measurements show great losses of soil under the constant production of intertilled crops as compared with sod. The North Carolina measurements show a somewhat less loss of nitrogen, a greater loss of phosphorus and a much greater loss of potassium through the eroded material than through the continuous crops of corn and cotton.

At the erosion experiment farm at Spur, Texas, measurements have been made on the Miles clay loam having a grade of 1 to 3 per cent., a length of slope of 96 feet and an average rainfall of 27 inches. With a grade of 2 per cent. the annual acre loss for three years has been: from cultivated uncropped land 18.6 tons, from continuous cotton 12.6 tons, from continuous Milo maize 5.7 tons, and from continuous Buffalo grass sod 3.8 tons. As compared with those

on the 9 per cent. slope in North Carolina these losses on this 2 per cent. slope are remarkably high, showing again the marked variations to be expected under varying conditions of soil and precipitation.

Careful estimates of the soil lost from individual farms have been made in only a few instances. At the erosion experiment farm in northern Missouri, a careful determination of the depth of the soil at 100-foot intervals over the 220-acre tract shows erosion losses, as compared with similar uneroded land, varying from less than an inch to more than 12 inches. Naturally, the 12-inch losses are confined to the steeper grades and the small losses to the more level areas. When these losses are applied to the whole 220 acres, the average loss is almost exactly one inch. Since the average depth of soil is around 10 inches, approximately one tenth of the surface soil has been removed since the land was put into cultivation, or in about 50 years. This land has been handled largely as a livestock farm, and the cropping system has included a good deal of grass so that the erosion has not been excessive. The rate of one inch in 50 years or seven inches in 350 years is identical with that of the corn, wheat, clover rotation on the 3.68 per cent. grade in the Missouri measurements which is probably not far from the average corn belt loss under a good system of cropping. It is, however, from the steeper than average grades and under poor systems of soil preservation that the serious losses occur.

It is quite evident, from the data available, that the erosion factor in soil deterioration is a very significant one, although its importance varies greatly with conditions. Under nature the advancing stages of early erosion may remove good virgin soils which may later be replaced by much poorer ones, yet it is under agriculture that the most rapid changes take place. Under the most favorable conditions for erosion a type of agriculture poorly adapted to soil preservation may allow the entire surface soil to be removed within a generation, or in the case of the very steep grades within a decade.

The relation of climate to the rate of erosion losses is very significant. Generally speaking, erosion losses are low in the cooler climates where the surface is frozen for several months of the year and they are higher in the warm climates. They are high where the precipitation is 20 inches or more and where there are many rains of torrential character. Erosion losses are, therefore, low in the northern part of the United States and in most of northern Europe, since both the temperature and the character of the rainfall are such as to prevent excessive soil removal. These losses are highest where a temperate or subtropical climate leaves the soil unfrozen almost the entire year, and where torrential rains occur during the growing season when the soil is being cultivated. The greatest losses during a given season will occur when a torrential rain falls on bare, cultivated land already filled with the water of a previous rain.

The relation of soil character to erosion losses is not well understood. Middleton[4] has shown that the most important single factor governing the case of erosion of a soil mass is the so-called dispersion ratio, which refers to the proportion of the silt and clay easily dispersed in water. General observations show that as a rule soils having a medium texture of the surface soil (A horizon) such as silt loams, loams and fine sandy loams, suffer most, particularly from sheet erosion, and that such losses decrease as the texture approaches either extreme. If such surface soils are underlaid with a tight clay subsoil (B horizon) the losses from sheet erosion are intensified. While small gullies form readily in soils of medium texture with tight subsoils, deep gullies are developed most rapidly when such surface soils are underlaid by loose silt loam, sandy or sandy loam subsoil. If the deeper soil material is also made up of loose silt or sandy loam, such as is characteristic of some of the loess deposits, uncontrolled gullies may assume frightful proportions. The most marked examples of this in the United States are in the belts of loessial soils lying on the east side of the Mississippi from the Ohio River southward.

In contrast to soils which are very susceptible to erosion there is evidence that some of the lateritic soils of the tropics do not erode seriously even under very excessive amounts of precipitation. It has been suggested that this is associated with the high silica and low sesquioxide content of these soils. Bennett reports that certain lateritic clays of Porto Rico and Cuba remain so porous and friable, even under cultivation, that they absorb great quantities of water and erode very little. Such soils differ greatly from the easily eroded soils of the southern part of the great group of podsolic soils of the United States.

The general relation of the percentage of grade to erosion losses is too well known to need particular comment. However, no exact mathematical expression of this relation with different soil textures is yet available. Because of the influence of such factors as soil granulation, the tightness of the subsoil, and the nature of the rainfall, mathematical relationships are very difficult to establish. Under most conditions land having a grade of over 10 per cent. must be handled with great care to prevent serious loss and under these natural conditions most favorable for

[4] U. S. Department of Agriculture Technical Bulletin 178.

erosion land with a slope of only 2 or 3 per cent. must be given particular attention to avoid excessive damage.

The relation of systems of farming to erosion losses has a very practical significance. When it is considered that bare or cultivated land suffers most and that such losses are largely overcome by the use of sod crops and greatly decreased by the use of small grain crops, the influence of the cropping system is at once apparent. The large acreages of corn in the corn belt and of cotton in the cotton belt are principally responsible for the excessive erosion losses which have taken place in those regions. Coupled with this has been the failure of the average farmer to realize the importance of such losses and as a result he has given little attention to the control measures which lie within his reach. Too often he has allowed sheet washing to proceed and gullies to go uncontrolled until whole farms and groups of farms have reached the stage of abandonment. The farmer should not receive too much blame for this, however, as corn and cotton are the principal money crops in these regions and he is human.

In summation it can be said that in considerable areas of the United States as well as of other countries, where the climate is temperate to subtropical, where other natural conditions are favorable to erosion, and where the systems of agriculture include large acreages of intertilled crops, the erosion factor is by far the most important one in bringing about serious soil deterioration. However, on the great majority of the farms in the corn and wheat belts and on many farms in the cotton belt, the losses are moderate. In some cases, such as very level lands, the losses are negligible. In fact, in the case of very level uplands the erosion losses may be too slow for the good of the land. It must be understood that a limited amount of erosion is beneficial. It is a rejuvenating process. In case of the very level virgin uplands of the humid regions the run-off and erosion are so small that these soils may become badly leached and low in basic material, while at the same time they may develop very tight subsoils with a resulting decrease in natural fertility and in productivity. The most productive virgin upland soils are those which are sufficiently rolling that the surface drainage is ample and from which sufficient erosion takes place that new layers of soil material are constantly, even if very slowly, brought within the action of surface weathering agencies and root penetration. Such soils are not excessively leached and they are not underlaid by excessively tight subsoils. Moreover, if systems of cropping and other means of erosion control are adopted for their proper preservation, these soils remain most productive under agriculture. However, in those regions where natural conditions favor erosion it is rather difficult, even with slight grades, to limit erosion losses to a point that is negligible. If the Missouri figures may be taken to represent southern corn belt conditions, a loss of one inch in 50 years from a moderate grade and under a good cropping system may be expected. Such a loss is not great and it seems quite evident that under proper systems of soil management in this region the average erosion may be reduced to a factor of no great importance. Moreover, in the northern part of the corn belt the conditions for erosion are less favorable, and while no accurate data are available, the losses must be less. It must be remembered, however, that in the corn belt as a whole only a small percentage of the farmers follow a system of farming which is most effective in limiting erosion losses. As a consequence in the rich loose silty soils of the southern and central corn belt, particularly where the topography is rolling to steep, erosion losses are taking place at a rate which allows erosion to rank first among the factors that lessen soil productivity.

Little accurate data are available from which to judge the rate at which weathering agencies will replace the surface layer of soil under erosion losses, but it is generally thought to be very slow. Of course, when the depth of the surface soil has been reduced to 6 or 7 inches the action of the plow in bringing layers of the subsurface soil into the plowed zone and the incorporation of organic matter with it tends to maintain a surface soil layer of plow depth. Moreover, there are experimental data, as well as practical information, which show that through the use of legumes or the incorporation of organic matter, along with the use of lime and fertilizers, raw subsoils may be made to produce good yields of crops. Naturally such a system necessitates considerable expense, particularly in the early years of its use, but where crops of rather high unit value can be produced such systems may be quite profitable. However, such soil rejuvenating systems are never likely to be as profitable as those in which the natural surface soil is preserved. It is highly important, therefore, that the farmers of the corn belt, as well as those of the cotton belt, be encouraged not only to follow systems of farming which minimize erosion losses but to put into practice wherever necessary those mechanical means of erosion control which have been shown to be effective, such as the use of terraces, soil saving dams and contour farming. It is the duty of the federal and state agencies dealing with agriculture to give special consideration to the erosion losses that are taking place and to encourage the general adoption of practical measures of control.

OBSERVATIONS UPON THE USE OF THE DIVINING ROD IN GERMANY

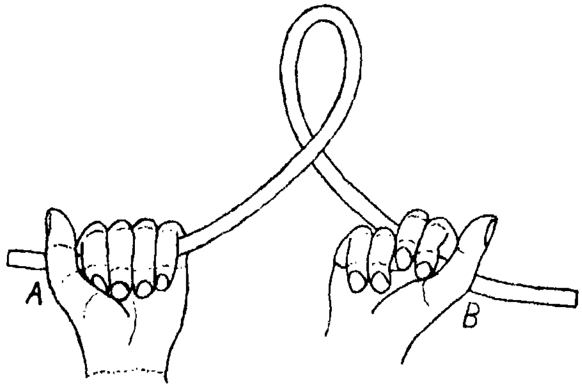
By Dr. C. A. BROWNE

BUREAU OF CHEMISTRY AND SOILS, U. S. DEPARTMENT OF AGRICULTURE

THE use of the divining rod, as a means for discovering subterranean supplies of water and metals, is usually dismissed with alchemy, astrology, table tipping and other occult sciences as a subject unworthy of serious consideration. The numerous books and articles upon rod operating which appear from year to year indicate, however, that the subject is one of constant and ever-increasing interest. During a recent extensive agricultural tour in various countries of Europe I was surprised to learn of the frequency with which the divining rod is employed to locate sources of water for estates, industries, towns, railroads, hospitals and other institutions. The recent statement of Professor J. W. Gregory that this repudiated instrument "is perhaps more used now than at any previous time" is in my opinion no exaggeration.

While visiting a large sugar beet estate near Magdeburg, Germany, last June, I was informed that its water supply had been located by a celebrated professional *Rutengänger* (rod walker), or dowser, and on July 6 I availed myself of an opportunity to observe this operator's method of working. He has acquired great notoriety in Germany for his success in finding subterranean water supplies, a publicity that has been enhanced by his numerous articles upon the subject. His published lists of references include several thousand names of estate-owners, factory officials, managers, contractors, etc., who all speak highly of his success in locating water supplies for their special needs. As this operator's method of using the rod and his views upon the subject differ so considerably from the accounts given in the literature upon water-divining the following account may be of interest.

A demonstration was given before a small private audience in a vacant lot in the suburbs of Magdeburg. The operator carried with him several loop-shaped rods of about the little finger's thickness (see cut) of steel, aluminum and other metals, the choice of the rod depending upon the nature of the test. Before beginning operations he fastened to his chest a padded leather jacket to protect himself against the blows of the implement. Selecting first a steel rod and grasping it with one end in each hand, palms upward (the left as at A and the right as at B), elbows against sides and the loop extended horizontally before him, he began to pace across the lot when sud-



denly the loop of the rod shot upward and struck the leather chest-protector a strong blow. The spot where this occurred, according to the operator, marked the edge of a subterranean stream. By continuing the survey in other directions the boundaries of this reputed stream were located. From the demarcations of the reactive zone obtained by another rod of aluminum (stated to be of greater sensibility) the depth of this stream was estimated and by observing the reaction with another rod the operator pronounced the water to be sweet; he also indicated the direction of the underground stream. He stated that with certain metallic ores the rod struck downwards while in the case of petroleum a vibratory movement of the rod took place. The operator made the curious statement that spots which lie above the intersection of subterranean water veins are particularly reactive and hence exposed to the danger of being struck by lightning. He stated that one end of the rod was positive and the other negative and that he could form conclusions as to the nature of underground deposits of coal, potash, petroleum, metallic ores, natural gas and other substances by comparing the reactions of his different rods first with the positive pole in the right and the negative in the left hand and then with these positions reversed. The technique of dowsing would thus seem to be more highly elaborated in Germany than in other countries.

When I attempted to use the rod myself no reaction was obtained. But when I grasped one end tightly with both hands side by side and the operator held the other end between the first two fingers and thumb of his right hand (as at B), and extended his left hand to within a few inches of my shoulder, the rod twisted strongly upward, as we came to the reactive

zone, notwithstanding all my efforts to prevent this by tightening the grasp of my hands. The same effect occurred when a third person, touching my arm, stood between me and the operator, who explained that had he actually touched us during this experiment the rod would have given me a serious blow because of the greater intensity of the reaction. The experiment of interposing another person in the circuit of rod and operator is frequently performed by dowsers and is held by many to prove that the motion of the rod is due to an external force. Barrett and Besterman in their book upon "The Divining Rod" (1926) describe many such experiments and come to the conclusion that it is a muscular action of the dowser that moves the rod. While it would seem impossible for a person to move the rod with only two fingers and a thumb in opposition to the efforts of two hands, I nevertheless believe that with the rod held as in position B, the muscular fingers of an experienced operator can secure a sufficiently strong grip upon the polished metal to move it against the combined resistance of two hands held side by side as at A. The rod in this case would function simply as a crank with the two hands at A serving as the bearings. It was noticed that the operator always held his right hand nearer to the loop of the rod and this would be the better position for producing a crank motion. The operator declared that there was no trick in the matter and that the rod moved without conscious effort upon his part.

When asked for an explanation of the force that moved the rod the operator replied that he could only offer a conjecture. It was his opinion that emanations of different highly penetrative rays were constantly escaping from the interior of the earth through the outer crust into space. These rays he thought to be absorbed in whole or in part by deposits of water, potash, coal, petroleum, minerals and other substances, with the production of surface areas more or less devoid of certain emanations. He compared these rayless zones with the shadows cast by the globe of a lamp upon the ceiling and supposed them to affect the sympathetic nervous system of his body in such a way that unconscious muscular contractions produced the movement of the rod. When asked if these so-called rayless areas could not be detected by physical methods he replied that Dr. Ambronn and others had devised electrical apparatus for locating hidden supplies of water and minerals, but nothing had yet been found so delicate as the human body. He claimed to have demonstrated the projection of these reactive rayless zones into space by making experiments with his rods in an airplane!

The operator stated that "rod-walking" was very exhausting, that his pulse rate went up to 140 beats per minute and that three hours per day was as long as he could operate without danger of collapse. He was of the opinion that his dowsing ability was the result of a tropical fever which left him with a supersensitive nervous system. His palms and fingers were calloused from frequent use of the rod. An inflamed appearance of the skin of his palms he attributed to burns produced by radiations at the positive and negative poles of the rod. Many of his statements were, in fact, a confused jargon about alpha and beta rays and other terms picked up from his loose reading of scientific books.

But apart from the absurdities and inconsistencies of his explanations, which after all were only conjectures, and disregarding the sensational claptrap of many features of his demonstration this operator has to his credit an unusually long list of undisputed successes. A prominent well-driller in Magdeburg informed me that he was correct in his predictions in over 90 per cent. of the cases, his failures being usually errors in estimating either the amount or the depth of the hidden water supply.

The opinion of several German scientists, whom I questioned regarding the reliability of dowsing as a method of locating water, was that after excluding the inevitable humbuggery and deception which attend so many performances of this kind there still remains the large residuum of successes, achieved by certain rod-operators, that could not be attributed to mere chance or luck. They thought it possible that these men might, perhaps, have inherited some primitive racial sense, not shared by other men, like the homing instinct of pigeons or migratory birds; or else that they might be gifted with an exceedingly acute unconscious power, sharpened by a wide prospecting experience, of rapidly correlating certain peculiarities of topography with the occurrence of subterranean water pockets. The former view is essentially the cryptesthetic theory of dowsing proposed by Barrett and Besterman in their book upon "The Divining Rod"; the other view of sharp observational ability is the one suggested by Gregory in his paper before the British Waterworks Association in 1927 upon "Water Divining"[1] in which he subjects the cases of Mullins, Stone and other operators, described by Barrett and Besterman, to a critical review. Whichever of these explanations be adopted, the rod itself is ruled out of consideration as a primary cause of the phenomenon. In fact several noted waterfinders, as the celebrated Abbé Paramelle of France,

[1] Reprinted in Annual Report of the Smithsonian Institution, 1928, p. 325.

and Gataker in England, have made no use of a rod at all. This implement would therefore appear to serve only as a helpful index for expressing certain states of the dowser's subconsciousness. What impressed me as peculiar in the Magdeburg demonstration was that the operator employed a heavy metallic rod instead of the traditional and more easily manipulated fork-shaped branch of a tree.

The explanation of an external physical force, as suggested by the German rod-walker, has nevertheless a large number of advocates, the best known of whom is, perhaps, Henri Mager, of France, whose views have been rejected by Barrett and Besterman and also by Gregory. This opinion has recently been revived again in a lecture before the Czecho-Slovakian Academy of Agriculture by R. Janota[2] who compares the body of the dowser to a wireless receiving set, the hands acting as the two electric poles, the legs as the earth line and the rod as the antenna. This lecturer states that just as some wireless receivers have certain defects so the human nervous systems of different individuals are not equally sensitive.

The Czecho-Slovakian Academy of Agriculture appointed a committee to investigate the phenomenon. Similar committees have been appointed in fact in many European countries but with unsatisfactory results. As Gregory has pointed out, "Testing the divining rod is difficult and promises no answer that will be universally accepted." Following the negative results reported in one test come the favorable results reported in another, as for example in the recent experiments at Johannesburg, where the celebrated English operator Stone, who used a clock spring for a rod, was reported to have been successful in finding hidden bags of gold.

With the growing population of Europe there has been a constantly increasing need of new supplies of water for agricultural, industrial and municipal purposes and this want is reflected in the increasing number of dowsers, *sourciers* and *Rutengänger* who are ready to supply the demand for their services. Even those who scoff at the rod as a relic of superstition do not hesitate to employ it should the occasion arise. In this respect they are following the attitude of Sir Herbert Maxwell, who once remarked, "I don't believe in the divining rod, but I don't deny that its virtues are genuine; and were I in straits to find water, I should employ without hesitation a professional water finder—rod and all—if there remains one so successful as Mullins was."[3]

OBITUARY

JUR. PHILIPTSCHENKO

JUR. PHILIPTSCHENKO, professor of genetics, died of meningitis on May 19, 1930, at Leningrad. He was born on February 1, 1882, in the family of an agriculturist-scientist residing in the province of Orel. After graduating at the University of Petersburg, in 1906, he continued studying for his professorship at the Zoological Cabinet of the university. In 1912 he presented his dissertation on the embryology of Apterygota, and the degree of master of zoology was conferred on him for it. In 1917 Jur. Philiptschenko obtained his doctorate on presenting another dissertation on the variability and heredity of the skull in mammals. In the meanwhile, he was elected first assistant professor, then reader in zoology, and in 1919 professor of the University of Petersburg, where he established the first chair of genetics in Russia and founded a new school of young geneticists. Besides his work at the university he gave lectures at several other superior schools. Since 1920 Professor Philiptschenko was in charge of the laboratory of genetics and experimental zoology in the Institute for Research in Natural Sciences at Peterhof. In 1921 he became chief of the bureau of eugenics and genetics at the Academy of Sciences. Some months before his demise Professor Jur. Philiptschenko was placed at the head of the department of genetics of the Institute of Animal Industry of the Lenin Academy of Agricultural Sciences in U. S. S. R.

His works, nine of which represent large manuals of genetics and experimental zoology, amount to 114 in number.

The publications of the earlier period of Professor Philiptschenko's scientific work (1905–1913) supply valuable data pertaining to the domain of anatomy and embryology of Apterygota; those of the later part (1914–1930) furnish important facts relating to genetics of animals and plants.

Professor Philiptschenko devoted the last seven years of his life to the study of the variability and heredity of quantitative characters in soft wheats, as well as of the process of development of the ear in wheat. Five of his works on these subjects were published in Germany, and a monograph by him on the genetics of soft wheats is being issued.

Professor Philiptschenko was a member of several Russian and foreign scientific societies as: Deutsche Gesellschaft für Vererbungswissenschaft, the Amer-

[2] Bulletin of the Czecho-Slovakian Academy of Agriculture, Vol. VI, No. 2, pp. 190–197, with report of discussion, *ibid.*, pp. 198–202. See also abstract, *Internat. Review of Agriculture*, Monthly Bulletin of Agricultural Science, May, 1930, p. 162.

[3] "Memoirs of the Months," I, 103–106: (1897).

ican Genetic Association, Deutsche Gesellschaft für Züchtungskunde, Société de morphologie de Paris, etc.

As to his personality, it should be mentioned that he was not only an eminent scientific investigator and a brilliant lecturer, but also an exceptional man, well known for his inexhaustible energy, kindness and responsiveness to the needs of all those who surrounded him. His death was a heavy blow to every one who knew him closely and a great loss for science.

M. RIMSKY-KORSAKOW
V. DOGIEL
M. ROZANOVA
T. LUS
T. LIEPIN

MEMORIALS

A MEMORIAL meeting in honor of the late Dr. Henry Leffmann was held in the auditorium of the Wagner Free Institute of Science on January 16, with addresses by Dr. Wilmer Krusen, president of the Philadelphia College of Pharmacy and Science; Dr. Howard McClenahan, president of the Franklin Institute, and Dr. Samuel T. Wagner, Jr., treasurer of the Wagner Free Institute of Science.

AN oil painting of Graham Bell, by Mr. W. W. Russell, R.A., was presented to the British Institution of Electrical Engineers by Sir Hugo Hirst on January 8.

THE council of the senate of the University of Cambridge has appointed the following committee to arrange for the celebration of the centenary of James Clerk Maxwell: The Vice-Chancellor, Sir J. J. Thomson; Mr. W. Spens, master of Corpus Christi College; Sir Joseph Larmor, Sir Ernest Rutherford, Dr. C. D. Broad, Professor H. F. Newall, Sir Arthur Eddington, Professor C. T. R. Wilson, Professor F. J. M. Stratton, Dr. J. Chadwick, Dr. J. D. Cockcroft, and Sir James Jeans.

THE centenary of the birth of the celebrated syphilologist Alfred Fournier will be celebrated on May 12, 1932, under the presidency of Dr. Lucien Hudelo, president of honor of the French Society of Dermatology and Syphiligraphy. Further information can be obtained from the general secretary, Dr. Sicard de Plauzoles, 44, Rue de Lisbonne, Paris, VIII^e.

ON the occasion of the opening of the Pasteur pavilion of the Instituto Bacteriológico of the National Department of Hygiene of Buenos Aires, which pavilion is devoted to studies of plague and mycology, a plaque was unveiled in honor of Pasteur. The president and ministers of the government of Argentina and representatives of the principal medical societies were present. The diplomatic representative of France, and Drs. C. Nicole, G. Araoz Alfaro and Ponce de Leon, made addresses.

RECENT DEATHS

DR. W. A. LIPPINCOTT, professor of poultry husbandry at the University of California since 1923, has died at the age of forty-nine years.

THE death at the age of fifty-six years is announced of Dr. Frederick J. Pritchard, senior plant physiologist of the U. S. Department of Agriculture.

EDGAR STEINER THOMSON, professor of ophthalmology at the Manhattan Post-Graduate School of Ophthalmology, Otology and Laryngology and at the New York Polyclinic Graduate Medical School from 1912 to 1917, has died at the age of fifty-nine years.

DR. WILLIAM A. JONES, professor of mental and nervous diseases for ten years, 1909 to 1919, at the University of Minnesota, and president of the State Board of Health from 1905 to 1917, has died at the age of seventy-one years.

DR. FELIX LÖHNIS, head of the laboratory of agricultural bacteriology at the University of Leipzig, has died at the age of fifty-seven years. Dr. Löhnis was in 1914 appointed soil bacteriologist in the U. S. Department of Agriculture and in 1923 was made senior bacteriologist in charge of the office of soil bacteriology investigations in the Bureau of Plant Industry. He resigned in 1925 to go to Leipzig.

Nature records the death of Mr. T. F. Bourdillon, formerly conservator of forests, Travancore, on December 19, aged eighty-one years, and of Professor Pierre Termier, inspector-general of mines and director of the service de la carte géologique, who was elected in 1909 a member of the Section of Mineralogy of the Paris Academy of Sciences, aged seventy-one years.

DR. A. O. THOMAS, professor of paleontology in the University of Iowa, died on January 13 at the age of fifty-four years.

SCIENTIFIC EVENTS

EXHIBITION OF THE PHYSICAL AND OPTICAL SOCIETIES IN LONDON

THE twenty-first annual exhibition of the Physical Society and the Optical Society was opened by Sir Arthur Eddington at the Imperial College of Science, South Kensington, on January 6. According to the account in the London *Times* the exhibition included a great variety of electrical, optical and other physical apparatus, much of it on view for the first time. The first evening discourse was delivered by Mr. E.

Lancaster-Jones on "Searching for Minerals with Scientific Instruments," and the second by Sir Gilbert Walker on "The Physics of Sport."

Among the demonstrations given by the Gramophone Company was a display of television, on a system developed by the company's research staff at Hayes, Middlesex. The work has reached the stage of an advanced laboratory experiment, but there is no intention of exploiting it commercially at present. The aim of the company is to produce a form of television that will be of definite entertainment value, without which, it is considered, no system can hope to be commercially successful. Attention has been concentrated on two points—the employment of a large number of picture elements to each unit area of the picture, in order to get definition, and some means of modulating the strong light needed to give an image of real entertainment value. The second of these requirements has been met by using a powerful arc lamp and designing apparatus to control this powerful source of illumination.

In the experiments which are to be shown at the exhibition, cinema pictures are transmitted along cables, and reconstructed on a screen measuring about 24 in. by 20 in., without the aid of lens magnification. Although for this demonstration the transmitter and receiver will be only a short distance apart, there would be no difficulty in using cables of any length between them. At a private view at the Gramophone Company's works some days ago, several film pictures were successfully transmitted by the apparatus, including pictures of street scenes in London and of a cricket match. The pictures are scanned at the transmitter in five sections of thirty lines each, a lens drum being used to traverse a succession of images over five scanning apertures. Photo-electric cells placed behind these apertures generate currents corresponding to the picture elements, and these currents are amplified and transmitted along five separate channels. At the receiver, further amplification is necessary before the picture pulses are applied to a multiple Kerr cell. The received image is reconstructed by means of a mirror drum driven synchronously with the transmitter, and thus projected on the screen.

BUDGET FOR THE U. S. DEPARTMENT OF AGRICULTURE

ACCORDING to *The Official Record* the budget of the U. S. Department of Agriculture for the fiscal year 1932 as submitted by the President to the Congress recommends that a total of $225,537,476 (including $137,500,000 for roads) be provided for all activities conducted or administered by the department, as compared with $174,345,474 for all purposes for the fiscal year 1931, or an increase of $51,192,002 over total funds appropriated for 1931 up to December 1, 1930.

The 1932 budget includes a proposal for the establishment in the department of a Bureau of Agricultural Engineering, to which the work now conducted by the division of agricultural engineering of the Bureau of Public Roads, together with a portion of the appropriation of the latter bureau for general administrative expenses, is recommended to be transferred. As all the operations of the farm which involve the use of construction materials, labor, power, machinery and improvement of the land by irrigation, drainage and erosion lie partly within the field of engineering, it is felt that, in order to secure the most effective coordination of effort within the department and in its relations with the state agricultural colleges and experiment stations and with commercial and other non-governmental agencies, the agricultural engineering work should be segregated from road construction activities and set up as a distinct unit coordinate with the other major subdivisions of the department.

The recommended increases for 1932 include items totaling approximately $1,200,000 for expanding the research of the department, and $700,000 additional for continuing the building program at the forest products laboratory at Madison, Wisconsin. Among the increases for research are $30,000 for animal husbandry investigations; $25,000 for poultry investigations; $63,000 for investigating diseases of livestock; $80,000 for dairy research projects; $180,000 for investigations of the Bureau of Plant Industry; $227,000 for forestry research under the McNary-McSweeney Act; $113,000 for projects of the Bureau of Chemistry and Soils; $156,000 for research by the Bureau of Entomology; $93,000 for activities of the proposed new Bureau of Agricultural Engineering; $210,000 for marketing investigations of the Bureau of Agricultural Economics; $40,000 for investigations of the Bureau of Home Economics, and $70,000 for expanding the soil-erosion program. Also an increase of $58,000 is recommended in the department appropriation for printing, a large part of which is for the publication of manuscripts on scientific subjects.

The budget also includes increases of $21,000 for the motion-picture work of the Extension Service; $360,000 for extending the service of the Weather Bureau in aid of civil aviation, under the air commerce act; $250,000 for payment of indemnities in connection with tuberculosis eradication in California; $186,000 for the administration and protection of the national forests and $280,000 for construction and maintenance of national forest improvements; $75,000 for cooperation with states in fire control on state

and privately owned timberlands, under the Clarke-McNary Act; $28,000 for the protection of migratory birds, $200,000 for the acquisition, maintenance and administration of bird refuges under the migratory bird conservation act, and $150,000 for the acquisition of additional lands for the Cheyenne Bottoms Bird Refuge, under the Bureau of Biological Survey; $25,-000 for extending the market inspection service, $43,-000 for the market news service, $300,000 for enforcement of the perishable agricultural commodities act of June 10, 1930, $23,000 for enforcement of the grain standards act, and $57,000 for the administration of the warehouse act, under the Bureau of Agricultural Economics; $70,000 for strengthening the plant-quarantine inspection service of the Plant Quarantine and Control Administration; $27,000 to provide more adequately for the enforcement of the grain futures act; $200,000 for increasing inspection and analytical work connected with the enforcement of the food and drugs act; and $35,000 for the collection of loans made to farmers in previous years in flood, storm and drought-stricken areas.

The budget provides for the transfer of the department's experiment station at Fairbanks, Alaska, to the Alaska Agricultural College and School of Mines, and for the abandonment of the department stations at Sitka and Kodiak, Alaska, entailing a reduction of $28,750, which, however, is offset in part by a recommended appropriation of $15,000 to be paid to the Territory for the agricultural experiment station. Other decreases in the budget include $75,000 for operation of Center Market in Washington, on account of the proposed closing of this market on January 1, 1931, in connection with the federal building program; $50,000 for corn borer control, incident to removal of the requirement with respect to certain regulated products, and $30,000 for control of the Asiatic beetle, due to the lifting of the quarantine against this pest.

Provision is made in the budget for an increase from $11,000,000 to $12,500,000 for forest roads and trails and from $75,000,000 to $125,000,000 for federal-aid highways in connection with the enlarged construction programs contemplated by the acts of April 4, 1930, and May 5, 1930.

Included within the increases provided by the budget for 1932 is a total of $268,287 for salary adjustments under the provisions of the Brookhart Salary Act of July 3, 1930, amending the classification act of 1923. This amount is exclusive of approximately $30,000 for Brookhart Act salary adjustments of employees carried on certain special appropriations, such as the Federal-aid highway and forest road and trail funds, which have been absorbed by these appropriations without increase in their totals.

The budget also includes, distributed throughout the appropriation items, recommended increases totaling $223,820 for underaverage salary grade adjustments.

CHECK LIST OF THE BIRDS OF THE WORLD

THE Museum of Comparative Zoology announces that the first volume of a Check List of the Birds of the World by James Lee Peters is now in press and will be issued shortly.

The classification followed for the higher groups is that proposed by Dr. Wetmore, with the sequence of genera and species according to the author's own ideas where no authoritative treatment has been published. The first volume will contain about three hundred genera and one thousand seven hundred species and subspecies covering the following orders:

Struthioniformes, Rheiformes, Casuariiformes, Apterygiformes, Tinamiformes, Sphenisciformes, Gaviiformes, Colymbiformes, Procellariiformes, Pelecaniformes, Ciconiiformes, Anseriformes, Falconiformes.

The only recent attempt to list most of the species in these groups was that made in the first volume of Sharpe's Hand-list published in 1899 and consequently now thirty-two years old and out of date.

It is expected that at least ten volumes will be required to complete the work. The second volume is in active preparation and preliminary work on others is under way.

The new check list is not a museum publication and will not be distributed to the museum's exchange list, but will be published by the Harvard University Press.

CONFERENCE ON HUMAN PROBLEMS IN INDUSTRY

A SCIENTIFIC study of human problems in industry, directed at the roots of such social evils as unemployment, middle-age obsolescence, labor unrest and strikes, will be made at the Institute of Human Relations at Yale University, with the cooperation of leading industrialists and engineers, according to an announcement made following a conference on January 13 in New Haven between a committee of the American Society of Mechanical Engineers and members of the institute.

Members of the committee, which will act in an advisory capacity in the study, are E. W. Rice, Jr., honorary chairman of the board, General Electric Company, Schenectady, N. Y.; H. E. Howe, editor, *Industrial and Engineering Chemistry*, Washington, D. C.; Ralph E. Flanders, general manager, Jones and Lamson Machine Co., Springfield, Vermont; D. M. Bates, president of Bates, Inc., Philadelphia; J. P. Jordan, partner of Stevenson, Harrison and Jordan, New

York City; and Henry M. Crane, technical assistant to the president of General Motors Corporation, New York City. Members of the institute at the conference were Dean Charles H. Warren, Sheffield Scientific School; Dean M. C. Winternitz, Yale School of Medicine; Dean Edgar S. Furniss, Yale Graduate School; George Parmly Day, treasurer, Yale University; Professor S. W. Dudley; Professor Mark A. May, executive secretary of the Institute of Human Relations, and Professor Elliott D. Smith, Yale University, director of the study.

The industrial committee of the institute, already formed and at work, includes among others a psychiatrist, a psychologist, an economist, a lawyer and a sociologist, directed by an engineering and management group interested in focusing the attention of these specialists upon various phases of the development of human problems in specific industrial organizations.

"In the solution of this problem," the committee states, "there arise many important questions related to the major human sciences; such physiological problems as fatigue, such medical problems as occupational diseases, such psychological problems as capacity to learn, such psychiatric problems as the emotional effects of fear of loss of job, such social problems as absorption by the community of workers thrown out of employment, such economic problems as the absorption of increased output, such legal problems as adaptation of labor legislation to technological change, while in its very structure it is a problem of engineering and of management."

The first instance of increased technological efficiency to be studied will be the "stretch-out"—the recent rapid increase in the number of spinning frames and looms tended by the individual worker. This preliminary study will provide material for a comparison of procedures and effects. It will be a contribution of distinct practical value, the committee believes, by calling to the attention of managers the nature of the social problems involved and the extent to which they are dependent upon good managerial handling.

AMERICAN ASSOCIATION OF TEACHERS OF PHYSICS

At the Cleveland meeting of the American Association for the Advancement of Science an organization was formed for the purpose of promoting and improving the teaching of physics of college and university grade, under the name "American Association of Teachers of Physics." The new organization fills a need long felt by those interested in methods of instruction, from the pedagogical as well as from the laboratory and demonstration points of view. A tentative constitution was adopted, and an executive committee chosen to perfect plans for the organization, which are to be discussed and acted upon at the New Orleans meeting. Regional, as well as general, meetings are to be held. The first general meeting is to take place at the Bureau of Standards in April, in connection with the regular meeting of the American Physical Society. At this meeting, Dr. A. W. Hull, assistant director of research of the General Electric Company, will present a paper on the training of physicists for industry.

Officers elected for the ensuing year are: *President,* Dean Homer L. Dodge, University of Oklahoma; *Vice-president,* Dr. P. E. Klopsteg, Central Scientific Company; *Secretary-Treasurer,* Professor W. S. Webb, University of Kentucky. The executive committee consists of the officers and the following members: Professor O. B. Blackwood, University of Pittsburgh; President Karl T. Compton, Massachusetts Institute of Technology; Professor R. S. Minor, University of California; Dean F. K. Richtmyer, Cornell University; Professor M. N. States, University of Kentucky; Professor B. A. Wooten, University of Alabama. Applications for charter membership will be received until June 1, 1931.

SCIENTIFIC NOTES AND NEWS

The William Wood Gerhard Gold Medal of the Pathological Society of Philadelphia was presented on January 8 to Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research.

Professor Ernst von Romberg, of Munich, informs the *British Medical Journal* that the commission entrusted with the grant of the Dr. Sophie A. Nordhoff-Jung Cancer Prize for the best work of recent years in the field of cancer research has unanimously awarded this prize to Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, for his development of the method of tissue cultivation and his application of it in the solution of the basic problems of pathological growths, especially the growth of malignant tumors. The commission was composed of Professors Borst, Döderlein, von Romberg and Sauerbruch.

The Geological Society of London on January 16 awarded the Bigsby Medal to Dr. Norman L. Bowen, of the Geophysical Laboratory of the Carnegie Institution at Washington, in recognition of the value of his study of the physical chemistry of igneous rocks.

AWARD of the William H. Nichols Medal of the New York Section of the American Chemical Society for 1931 to Dr. John Arthur Wilson, of Milwaukee, Wisconsin, is announced. The award, bestowed for outstanding achievement in colloid chemistry, applied particularly to leather and sanitation, will be presented to Dr. Wilson at a national gathering of chemists in New York on March 13. Speakers at the ceremony will include Professor Arthur W. Thomas, of Columbia University, and Dr. Clarke E. Davis, production manager of the National Biscuit Company.

DR. HERBERT LEVINSTEIN, the English chemist, has been awarded the medal of the Society of Chemical Industry. The medal is awarded not more frequently than once every two years for "conspicuous services to applied chemistry by research, discovery, invention or improvement." Dr. Levinstein, who is the eighteenth recipient of the honor, did much work on the Chemical Warfare Committee and is known as an authority on poison gas.

THE Swedish Gold Medal for physical education, awarded by the Swedish Gymnastic Federation, was presented to Dr. Philippe Tissié at the International Ling Congress, recently held at Stockholm.

DR. E. R. CUMINGS, head of the department of geology of Indiana University, was elected president of the American Paleontological Society at the twenty-second annual meeting at Toronto.

DR. W. P. FRASER, of the University of Saskatchewan, has been elected president of the Phytopathological Society of Canada.

THE Pathological Society of Philadelphia has reelected for the year 1931 the officers of the previous year, namely, Dr. Balduin Lucke, *president;* Dr. V. H. Moon, *vice-president*, and Dr. Isolde T. Zeckwer, *secretary-treasurer-recorder.*

DR. KARL VON GOEBEL, professor of botany in the University of Munich, has been elected president of the Bavarian Academy of Sciences.

PROFESSOR EDWARD SAPIR, of the University of Chicago, has been appointed Sterling professor of anthropology and linguistics at Yale University. Dr. Sapir will also be a member of the staff of the university's Institute of Human Relations and will act as chairman of a new section of the department of social sciences devoted to cultural anthropology.

DR. MARGARET E. MALTBY, associate professor of physics at Barnard College, will retire at the end of the college year after serving as a member of the faculty for thirty years.

DR. OWEN THOMAS JONES, Woodwardian professor of geology at the University of Cambridge, has been elected to a professorial fellowship at Clare College.

DR. HERMON CAREY BUMPUS has been appointed chairman of the educational advisory board of the National Park Service, succeeding Dr. John C. Merriam.

THE members of the new National Advisory Health Council, created by an act of Congress to advise the Surgeon General of the U. S. Public Health Service on matters pertaining to the health of the country at large, have been appointed. Four members of the advisory committee of the old Hygienic Laboratory who will serve on the council are: Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research; Dr. M. P. Ravenel, professor of bacteriology at the University of Missouri; Dr. M. J. Rosenau, professor of public health and hygiene at the Harvard Medical School, and Dr. William H. Welch, of the Johns Hopkins University. The other members are: Dr. W. S. Leathers, dean of Vanderbilt University School of Medicine; Dr. Haven Emerson, professor of public health and hygiene at Columbia University; Professor S. C. Lind, head of the department of chemistry, University of Minnesota; Dr. W. H. Howell, director of the Johns Hopkins School of Hygiene; Dr. C.-E. A. Winslow, professor of public health at Yale University, and Dr. Alfred Stengel, professor of the practice of medicine at the University of Pennsylvania.

DR. EDWARD LAURENS MARK, of Harvard University, director of the Bermuda Biological Research Institute, sailed for Bermuda on January 17. He was accompanied by a number of scientific men, including Dr. Charles Benedict Davenport, Dr. Ross Granville Harrison and Dr. Edwin Grant Conklin.

DR. JOHN C. MERRIAM, president of the Carnegie Institution; Dr. A. V. Kidder, chairman of the division of historical research, and Mr. H. B. Roberts, staff archeologist, have left Washington to undertake a tour of inspection of the ruins of the old Mayan Empire in northern Guatemala. They were expected to reach Puerto Barrios about January 19. The ruins at Uaxactun, the oldest of known Mayan cities, have been the scene of Carnegie Institution excavations since 1926. In addition it is planned to make a brief reconnaissance of certain areas which have been considered in connection with the program of the institution.

PROFESSOR M. F. JORDAN, of the University of Maine, is spending a sabbatical leave at the Perkins Observatory, conducting special investigations in cooperation with the research program of the observatory.

Dr. Charles H. Rogers, of the department of pharmaceutical chemistry of the University of Minnesota, will leave in March for Europe, where he will join Mrs. Rogers, who has been spending the winter in Spain, northern Africa and France with Professor and Mrs. Francis B. Barton, of the department of Romance languages. Besides touring through the principal continental countries, Dr. Rogers will study the chemical and pharmaceutical plants in Europe. He and Mrs. Rogers will return to Minneapolis in time for the fall quarter.

Dr. Melville J. Herskovits, associate professor of anthropology at Northwestern University, sailed from New York on January 21 for a six months' expedition to West Africa, to seek further evidence that the slaves of Cuba, Hayti, Brazil and the United States came from this part of West Africa.

Professor Paul Ehrenfest, of the University of Leiden, visited the Bartol Laboratory of the Franklin Institute from January 6 to 17, where he conducted a series of colloquia on "Atomic Physics."

Dean R. L. Sackett, of the School of Engineering at the Pennsylvania State College, is making a speaking trip through the southern universities at the behest of the American Society of Mechanical Engineers. He will also address the Atlanta and New Orleans sections of the society. Dean Sackett expects to go as far west as Tucson, Arizona, where he will remain for several weeks. He will speak to engineering students in other institutions on his way back, returning to State College in April.

On December 9, Dr. S. O. Mast, professor of zoology at the Johns Hopkins University, lectured at Cleveland, under the auspices of the McBride Lecture Fund. The subject of his discourse was "Concealing Coloration in Animals."

Dr. A. M. Banta, research professor of biology at Brown University and research associate of the Carnegie Institution, delivered an address on "What the Crustacean Tells us about Evolution," before the Washington Academy of Sciences on December 18.

Dr. Alexander Silverman, head of the department of chemistry of the University of Pittsburgh, delivered an illustrated lecture on "The Chemistry and Technology of Glass" before the University of Illinois Section of the American Chemical Society on January 12. The lecture was also given before the Indianapolis Section on January 13, and before the Purdue University Section on January 14.

Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, recently addressed the Students' Liberal Club on "What Can Science Say Concerning the Origin of Life and the Destiny of the Universe?"

Dr. Karl Menger, professor of mathematics in Vienna, who is lecturing at Harvard University during the winter semester, will lecture during the summer at the Rice Institute, Houston, Texas, on metrical geometry and on the dimension and curve theory.

Under the auspices of the Harvard division of philosophy, Professor R. F. Alfred Hoernlé will give a lecture on "Theory of Knowledge at the Crossroads" on January 28. Professor Hoernlé was assistant professor of philosophy at Harvard during the years 1914–20, and is now professor of philosophy at the University of the Witwatersrand, Transvaal, South Africa.

Dr. Othenio Abel, professor of paleontology and paleobiology at Vienna, will deliver this spring a course of lectures at the University of Paris.

A building to be erected for the Harvard College Observatory at a cost of $100,000 is planned for the safe preservation of the photographic collections and other records of the observatory. Irreplaceable pictures of all portions of the sky—the first made in 1850—taken from the Northern and Southern Hemispheres and now stored in a wooden building, will be laid away for future study and reference in special vaults which will be placed in the projected building. Numbering more than 350,000 plates, and collected at a cost in excess of $1,000,000, the collection is five times larger than that of any other institution in the world. Space will be allowed for the collections of the next forty years.

A gift of $700,000 eventually will go to the Johns Hopkins Hospital by the will of William A. Marburg, former vice-president of the American Tobacco Company, which disposes of an estate of $2,100,000. The $700,000 goes to the hospital upon the death of the last surviving child of Theodore Marburg, formerly minister to Belgium, a brother of William Marburg. Another trust fund of $50,000 for his sister is to go to the hospital upon her death.

Museum News states that: The Cleveland Museum of Natural History has been given a 100-acre tract of land on Sperry Road to be developed as an arboretum. With the land goes assurance of cooperation and financial backing by the trustees of a large private estate of Cleveland. The land was given to the museum by Mr. and Mrs. Benjamin Patterson Bole and their son, Benjamin Patterson Bole, Jr. For its development as an arboretum the museum will have the larger part of the income from the Elizabeth Davis Holden Memorial Fund, established by the late

Albert F. Holden, Mrs. Bole's brother. In addition, Mr. and Mrs. Bole have given the museum an option to buy additional lands on the basis of present values, and will provide funds for preparing the program of the arboretum, which will be known as the Holden Arboretum. Announcement of the gift and the plan of cooperation between the museum and the trustees of the Holden estate was made at a dinner, attended by 441 people, in celebration of the tenth anniversary of the establishment of the museum.

THE council of the senate of the University of Cambridge has recommended the acceptance of the offer of the council of the Royal Society to provide within three years a sum of £15,000 towards the building and equipment of a laboratory for special physical investigations in the University of Cambridge, to be used in the first instance for magnetic and cryogenic research.

THE editor of *Chemical Reviews*, Dr. Gerald Wendt, announces that beginning with 1931 the journal will be doubled in volume, carrying twice as much material as heretofore. The journal will be published in two volumes instead of one, and will be changed from a quarterly to a bi-monthly. The volumes will begin in February and August. The expansion makes it possible for *Chemical Reviews* to publish promptly the papers of the important symposia of the society, as well as others from all over the world. To members of the American Chemical Society *Chemical Reviews* will continue to sell for $4.00 a volume, or $7.00 for both volumes when they are ordered at one time. The price to non-members is $5.00, or $9.00 for both volumes.

Industrial and Engineering Chemistry reports that the thirteenth exposition of Chemical Industries will include exhibits on three floors of the Grand Central Palace, New York, devoted to the raw materials for the manufacture of chemicals and chemical products, technical products used in the arts and industries, apparatus and equipment, machinery and the finished products of the chemical industries. The exposition will be held during the week of May 4, 1931. Special sections will be devoted to the showing of raw materials from the Southern States, the natural resources of Canada and its provinces, new metals and alloys, laboratory supplies and equipment, materials handling and containers. The machinery and apparatus will vary from laboratory equipment through instruments of precision to equipment for large-scale operations. Special fundamental operations of the chemical industries will be shown in demonstrations including disintegration, crushing, grinding, grading, mechanical separation, including filtration, classification, settling, thickening, evaporation, distillation, drying, weighing, measuring, mechanical handling and conveying. Demonstration of the materials of construction will include ceramic materials, glassware, metals, alloys, plastics, wood fibers, fabrics and materials developed for special purposes. The students' course on the fundamentals of chemistry and chemical engineering will again be under the chairmanship of W. T. Read, dean of the School of Chemistry at Rutgers University.

Nature states that the section for scientific and optical instruments and photographic apparatus at the British Industries Fair, Olympia, London, which will be held from February 16 to 27, will occupy some 6,000 square feet on the ground floor of the Grand Hall. A joint exhibit has again been organized by the British Optical Instrument Manufacturers Association. There will be instruments for all branches of research and industry and for educational purposes, including a particularly fine exhibit of visual aids to teaching. It is, perhaps, not generally known that British manufacturers of optical glass supply lenses to America for cinema cameras and projectors, and that one firm is actually exporting the bulk of its spectacle lenses to the United States. Every kind of modern optical instrument is obtainable from British manufacturers, and there are some British instruments not made elsewhere which are used all over the world, including Germany. There will be a novel display of marine and aerial lighting equipment, including a flashing buoy-light and aerodrome floodlights and models of lighthouses and airway beacons. The section for chemicals at the fair will occupy some 11,000 square feet on the ground floor of the grand hall. Invitations to the fair may be obtained by scientific workers, teachers and others on application to the Department of Overseas Trade, London, which entitle the holder to travel to and from the fair by rail at the rate for a single journey plus a third.

AN exhibition of the Andrée Expedition relics opened in Liljevalch's Art Gallery in Stockholm on January 6. The exhibition, which occupies eight large rooms, consists of 550 objects, and gives a vivid impression of the immense difficulties surmounted by Andrée and his two companions in carrying such a large number of things, including a big canvas boat three sledges, food supplies, and a medicine chest, still well stocked. Special interest centers in Andrée's woollen jersey, in which the famous notebook was wrapped; the Primus stove, which still works perfectly; and lantern slides reproduced from the 30 or so remarkable photographic negatives skilfully developed after they had rested 33 years in an icy wilderness.

Industrial and Engineering Chemistry states that at the Atlanta meeting the council of the American

Chemical Society instructed the secretary to report at Cincinnati upon possible plans for providing retiring annuities for the staff of the society. This report was made and the council recommended action on the part of the directors. The directors have now voted that present employees of the society after twenty-five years of service, having hereafter reached the age of at least sixty years, shall on retirement be paid annually for life an amount equal to one per cent. of their average salary for the last five years of their service, multiplied by the number of years of service. It is further understood that this action shall not in any way affect the right of the society to discharge any employee. The directors further instructed the treasurer to set aside a reserve fund of $50,000 for employees' retirement, and recommended to future directors that the amount of the fund be adjusted as needed.

DISCUSSION

THE OCCURRENCE OF NATURAL AND ACQUIRED IMMUNITY TO INFECTIOUS MYXOMATOSIS OF RABBITS[1]

In reporting investigations concerning the virus of infectious myxomatosis of rabbits, Moses (1911)[1] noted that the wild rabbit of Brazil was resistant to infection except in rare instances. In our work with the virus the common laboratory rabbit has proved susceptible in every case, over two hundred and fifty rabbits being used for various experiments during the last five years. Findlay (1929)[2] has reported the Belgian hare to be susceptible and we have found the Flemish Giant likewise susceptible. This would be expected since they are varieties of the common laboratory rabbit.

In an earlier paper (Hobbs, 1928),[3] it was suggested that the western jack rabbit and the varying hare or northern snowshoe rabbit might also be immune to this virus. Since then it has been possible to secure live specimens of *Lepus californicus* Gray, the black-tailed jack rabbit, *Lepus americanus* Erxleben, the varying hare, and *Sylvilagus transitionalis* Bangs, the common wild cottontail. Two animals of each species were obtained and all proved immune to skin inoculation with the infectious myxomatosis virus. As is true in certain of the other virus diseases, this natural immunity seems to be a tissue immunity since it has not been possible to demonstrate any virucidal property in serum from either the jack rabbit or the wild cottontail. Whether this immunity can be broken down by means of giving massive doses of virus or by using other routes of inoculation and whether virucidal antibodies can be produced in these wild hares and rabbits are among the several problems that suggest themselves.

In the large number of laboratory rabbits which have been used in our experimental work, only one individual has shown any signs of resistance to the virus and it was a member of a group that had received repeated injections of killed virus. It had a severe case but eventually recovered and has proved immune to subsequent inoculation. That its resistance was due to the previous injections of killed virus can not be claimed, of course, since Sanarelli (1898)[4] reported that two of his animals recovered spontaneously from the infection. Virucidal antibodies were demonstrable in its blood two months after its recovery and are still demonstrable, eighteen months after recovery by means of the following technique. A 5 per cent. suspension of virus was prepared by grinding freshly removed myxomatous tissue in normal saline in a mortar. The suspension was then centrifuged for fifteen minutes at low speed and 0.5 cc quantities of the supernatant added to 0.5 cc quantities of serum from the above rabbit, of normal rabbit serum and of normal saline. These mixtures were then incubated at 37° C., being shaken every thirty minutes. At the end of two hours, the mixtures were removed and inoculated into susceptible rabbits. The rabbits inoculated with the immune serum mixtures never showed any signs of myxoma at the sites of inoculation or elsewhere, while the control rabbits developed typical myxoma nodules at the sites of inoculation and died from the infection.

These experiments would suggest the existence of a genus immunity to infection as the laboratory rabbits all belong to the genus *Oryctolagus* (not *Sylvilagus* as stated in my earlier paper), while the wild hares are placed in the genus *Lepus* and the wild wood hares or cottontails of North and South America are placed in the genus *Sylvilagus* according to the classification of M. W. Lyon given in the Encyclopaedia Britannica, thirteenth edition, 1926. In this the wild rabbit of Brazil is called *Sylvilagus* (not *Lepus*)

[1] A. Moses, "O virus do mixoma dos coelhos," Mem. Inst. Oswaldo Cruz, 3, 46, 1911.

[2] G. M. Findlay, "Notes on Infectious Myxomatosis of Rabbits," *Brit. Jour. Exp. Path.*, 10, 214, 1929.

[3] J. R. Hobbs, "Studies on the Nature of Infectious Myxoma of Rabbits," *Amer. Jour. Hyg.*, 8, 800, 1928.

[4] G. Sanarelli, "Das myxomatogene Virus," *Centr. Bakt.*, Abt. 1, 30, 865, 1898.

brasiliensis and is said to be very closely related to the wild cottontail of North America. Whether European species of *Lepus* and wild species of *Oryctolagus* would show a natural immunity to this virus is an interesting conjecture.

Our experiments are being continued and will be more fully reported at a later date.

JOSEPH R. HOBBS
DEPARTMENT OF COMPARATIVE PATHOLOGY,
HARVARD UNIVERSITY MEDICAL SCHOOL

NOTE ON THE CORN COMPONENT OF A RACHITOGENIC DIET

IN working with white rats and rickets the authors have found irregularity in the development of rickets on the Steenbock Diet 2965. The trouble has been traced apparently to the yellow corn component of the diet, and a satisfactory remedy was derived from the following experiment.

Thirty pounds of whole grain market yellow corn were equally divided. One half was immediately placed in a loosely covered earthenware crock, and the other half ground finely before storage in a similar container. Each lot was held at the variable room temperature of a dry laboratory for one year. At the end of this period of time the whole grain corn was ground in the same machine previously used, and twin batches of the above diet were compounded from these two samples of ground corn. The difference, obviously, was that one batch of meal was freshly ground from old corn, while the other batch had been aged as meal. A third lot of diet mixture employed cornmeal bought at a grocery.

The three diet mixtures were fed to animals selected equally from three litters of rats, and on the twenty-fourth day all animals were diagnosed by X-ray and line test, with the following result.

No. of animals	Peculiarity of diet	Positive rickets	Ave. gain in weight
6	Freshly ground corn	none	27 grams
6	Aged ground corn	6	19 "
6	Market corn-meal	6	8 "

We do not find in the literature the caution that whole market corn may contain an amount of antirachitic factor sufficient to interfere with desired development of rickets in white rats, if the corn be used freshly ground, but only the notation that storage of ground corn is attended with loss of growth-promoting factor. Since it is desirable to retain the growth-promoting vitaminic power but is imperative to avoid excess of antirachitic factor, one seems to be between the horns of a dilemma in respect to the corn component of this diet. A reasonable solution seems to be to store the ground corn-meal for six months and use it up in the next few months, and this procedure, for want of one more exact, serves as a successful expedient for insuring the development of a definite rachitic condition in white rats on a definite time schedule, with a simultaneous reasonable rate of gain in weight.

ROBERT S. HARRIS
JOHN W. M. BUNKER
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

WHEAT MOSAIC IN EGYPT

IN 1927–1929 the writer began investigations on a "new" wheat disease in Egypt for the Egyptian Ministry of Agriculture. It seems advisable to present a preliminary note at this time; later a complete paper will be published on various aspects of the problem. This disease was called to the writer's attention in December, 1927. The crop of 1928 was severely attacked. It was present to a somewhat less degree in the wheat crop of 1929 and has been reported to the writer as occurring in the crop of 1930.

In December, 1927, many completely yellow or chlorotic plants were sent to the mycology laboratory of the Giza agricultural farm. The same condition appeared on certain varieties of wheat in the varietal plots at Giza. The characteristic yellow color or chlorotic condition of the early stages of growth (when the plants were from one to two months of age) suggested the tentative names "yellows disease" or "wheat chlorosis," names by which it became known in Egypt. This condition was said never to have been seen on wheat in Egypt prior to 1927, and many explanations for its cause were forthcoming from staff members of the several divisions of the Ministry of Agriculture as well as from laymen.

Circumstantial evidence as well as established facts convince the writer that this malady had been present in Egypt for several years prior to the outbreak of 1928 but had escaped notice.

Diseased plants were scattered in a field and were not restricted to definite areas. There was no definite relation with respect to soil conditions. Normal plants were found next to a group of diseased individuals. The Hindi variety, one of the standard wheats of Egypt, was especially susceptible. Many fields were observed that had from 40 to 60 per cent. of the plants badly affected. The yield in these fields was reduced 20 to 40 per cent. Badly diseased plants were completely yellow or chlorotic in the early stages of growth and as the tillers began to form. The root

system at this age of the plant was apparently normal in expanse. Some plants died and appeared to be starved to death, but most of them reached maturity. Badly diseased plants never became more than one third or one quarter the size of a normal plant, having about the same number of culms but very small heads and shriveled grain. Plants which were completely yellow rarely showed any additional leaf or sheath symptoms as the season progressed. Those not completely yellow in the early stages, or which appeared normal up to the shooting stage but were slightly infected, characteristically showed yellow striping the entire length of the leaf, or mottled areas of yellow mosaic of short or long streaks. This sometimes occurred on only a few of the leaves. At times the writer discovered symptoms of green mosaic on the leaf and sheath, but this was exceedingly uncommon.

The rosette disease of wheat and the rosette of barley occur in Egypt. It is problematical how long these have been in Egypt, although members of the Ministry of Agriculture state they have been since 1925, but there is no published record to this effect. The writer found the rosette of wheat and barley in 1927 in many of the Egyptian provinces. He found barley affected also with what appeared to be a similar striping and yellow mosaic, and, from general appearances, indistinguishable from certain of the rosette mosaic symptoms occurring on wheat in the United States.

Data have been secured on varietal resistance to these diseases in wheat and barley, the effect of dates of planting, the effect of the "dry" and "wet methods" of sowing wheat, and the relation of soil temperatures and the occurrence of these mosaics. Also limited studies were made on artificial transmission of the disease by expressed juice and infested soils.

In light of the studies made on this wheat disease in Egypt, the writer regards it as one of the wheat mosaics and probably associated with the rosette disease. The reaction of certain varieties of spring wheat from the United States supplied by H. H. McKinney and grown in Egypt indicates that the viruses in Egypt and in the United States are dissimilar. This is substantiated by trials made of Egyptian varieties by McKinney[1] in the United States.

L. E. MELCHERS
KANSAS STATE AGRICULTURAL COLLEGE

THE FATAL BELGIAN FOG

ABOUT the week-end of December 7, an extremely heavy fog prevailed in Belgium and England, and the daily press reported that in the neighborhood of Liège more than forty persons and a considerable number of cattle died, exhibiting symptoms of asphyxiation. Autopsies performed on twelve cows indicated that they had died from pulmonary edema. Although final judgment on this phenomenon must await the results of the investigation which the Belgian government has undertaken, there are certain aspects of the situation which might be here referred to.

According to the New York *Times*, of November 30, 1930, a terrific sand-storm and hurricane blew over French Morocco on November 27. The following night, yellow sand was heavily deposited on the streets and on the foliage at Barcelona, Spain. On the morning of November 28, a "mud rain" fell in Paris and all over northern France as far west as Granville, on the southern Brittany coast and along the English Channel.

It seems probable that the more finely dispersed material carried by this storm reached considerable heights and settled down slowly over Belgium and England. These colloidal or semicolloidal dust particles served to reinforce the normally high atmospheric nucleation of the winter season; for, as Carl Barus has shown (Smithsonian publication 1309, published 1905) the products of combustion (burning coal, etc.) furnish highly efficient nuclei, and this atmospheric nucleation is especially marked in industrial neighborhoods and in the winter season. The tiny nuclei serve as centers about which, under suitable atmospheric conditions, moisture will deposit to form fog droplets. The extremely fine dust will continue to settle down for days and, given a sufficiently still and moisture-depositing atmosphere, prolonged and dense fogs would be expected.

This view is further confirmed by the fact that the *Evening Sun* of December 19, 1930, reported another terrific storm which swept over northern Algeria following a disastrous seven months' drought. Today's New York *Times* (December 22) carries a heading "Worst Fog in Years Paralyses London" (visibility only three feet at times).

The quantity of dust moved by storms of this character may be gauged from the fact that Hellman and Meimardus state that a cyclonic storm centered over Tunis about March 8 to 10, 1901, sucked up such a cloud of dust from the deserts that about one third of the 1,800,000 tons of dust that fell in Europe dropped north of the Alps. Apart from what fell into the Mediterranean Sea, they figured that about 150,000,000 tons were deposited on the African coast. Miller and Winchell estimated that the million or so tons of dust which fell with snow over an area of

[1] H. H. McKinney, "A Mosaic of Wheat Transmissible to All Cereal Species in the Tribe Hordeae," *Jour. Agr. Res.*, 40: 547–556, 1930.

about 100,000 square miles from Dubuque, Iowa, to Chelsea, Vermont, must have been carried over 1,000 miles at high altitudes from the arid southwest (Arizona and New Mexico) *before* it began to settle down.

It would seem probable, therefore, that the formation of fog in England and Belgium would easily be increased over a reasonable period of time following storms of the character recently reported.

The next point to consider is why, in certain localities, the fog was followed by fatalities. The following suggestion is offered as a possibility:

The newspaper reports indicate that the persons and animals were attacked suddenly with symptoms which, because of their abruptness and nature, lead one to suspect that they were in the nature of anaphylactic phenomena. The time of exposure prior to seizure was much too short to suggest the possibility of bacterial infection, and there seems to have been no ground whatever for the initial surmise that some hidden store of war poison-gas had suddenly escaped. It would seem possible that the heavy fog, in settling down, had accumulated in and on its droplets substances which precipitated the onset of anaphylactic shock in persons and animals previously sensitized. Thus, for example, it might be possible that castor bean cake containing the poisonous protein ricin had been used as a fertilizer in that neighborhood, and that some men and animals had become sensitized to it. The fog, in settling, might have accumulated and brought into the lungs of these sensitized beings sufficient ricin dust to occasion the onset of anaphylaxis. A few years ago, SCIENCE printed a note from a professor who had become sensitized to ricin and who had a violent attack of "hay fever" when someone in his laboratory merely opened a bottle of castor beans.

We do not, of course, know anything about the local situation, but it would be well if the possibility above suggested be kept in mind and search be made for conditions and substances which might be responsible for the onset of asthmatic or anaphylactic manifestations.

JEROME ALEXANDER

SPECIAL CORRESPONDENCE

COMMITTEE ON DRUG ADDICTION OF THE NATIONAL RESEARCH COUNCIL

IN January, 1929, the Bureau of Social Hygiene, Inc., offered to the National Research Council a sum of money to be spent in the study of drug addiction. The council accepted the funds and appointed in its Division of Medical Sciences a Committee on Drug Addiction to draft a plan of research work. The members of this committee are: Wm. Charles White, Charles W. Edwards, Carl Voegtlin, Torald Sollmann, Reid Hunt, C. S. Hudson, F. B. LaForge, Walter L. Treadway, Ludvig Hektoen, and the chairman of the Division of Medical Sciences.

After numerous conferences with those best equipped to give advice, the committee concluded that there were two avenues of study that might bring some help in the problem of drug addiction and it adopted these avenues as the most likely to succeed.

The first avenue of approach would be an attempt to replace all the uses to which addiction drugs are put by drugs without addiction properties. The basis for this attempt was: (*a*) that morphine had a high addiction property while codeine had a comparatively low addiction property, and codeine can replace many uses of morphine if used in larger doses; (*b*) that since the replacement of practically all the uses of cocaine, except in the surface application for anesthesia, with drugs having little or no addiction properties the importation of coca leaves has declined. That the latter condition should occur held out hope that if all the uses made of addiction-producing drugs could be limited to legitimate use only and in many cases drugs not having addiction-producing properties could be substituted for those with addiction properties, the difficulty of controlling the production of addiction drugs and of handling the national and international problems attending them would be rendered easier.

The committee found, however, that in the United States few chemists were interested in the field of alkaloid chemistry nor had been, as evidenced in the literature, for over a period of twenty-five years. The committee was agreed that to find substitutes for addiction-producing drugs it would be necessary to set up a unit devoted to analytical and synthetic work in the field of alkaloid chemistry. It found that one man, Dr. L. F. Small, had just returned to the United States to the University of Virginia after having spent two years of research under Professor Wieland on alkaloid chemistry. The committee immediately entered into negotiations with President Alderman, of the University of Virginia, and Professor Benton, of the Department of Chemistry there, and, owing to their sympathetic cooperation, a laboratory for the study of alkaloid chemistry was organized at the University of Virginia with Dr. Small in charge. The committee hopes that this unit may develop into a permanent unit for the study of alkaloid chemistry in the United States.

This unit could be filled in two ways, either by

sending chemists to Europe to study or by bringing chemists to this country to the University of Virginia, there to place with them four or five chemists to be trained by them under Dr. Small's direction. The latter plan was adopted, and with the cooperation of the United States Department of Labor the National Research Council brought to the University of Virginia Dr. Mosett and Dr. Burger from the laboratory of Professor Spaeth in Vienna. Dr. Small, Dr. Mosett, Dr. Burger and four chemists have been working at the University of Virginia for the past eighteen months on the synthesis and degradation of phenanthrene derivatives producing compounds of increasing complexity which resemble this nucleus of the morphine molecule in physiological function and in degradation compounds of the morphine molecule itself.

In order, however, to know what effect these compounds would produce, whether of value or of no value as substitutes for addiction-producing drugs, it was necessary also to have a unit which could test these chemical products in a systematic way for their biological action. Through the sympathetic cooperation of President Ruthven and the trustees of the University of Michigan, such a unit was arranged for in the department of pharmacology under the supervision of Professor Edmunds and Dr. Eddy. As soon as the chemical products are manufactured at the University of Virginia they are sent, with a report of their chemical composition and properties, to the University of Michigan where they are studied biologically and then reported upon. Both sets of reports are studied by the committee and the value of the substances determined. Some thirty new compounds have already been made at the University of Virginia and sent to the University of Michigan.

For such a plan of work there were various phases requiring the help of the United States government. This help and cooperation was freely granted by the United States Public Health Service under the direction of Surgeon-General Cumming and by the Narcotics Bureau under Commissioner Anslinger. Also two manufacturing houses rendered help by contributing rare chemicals for this study. These firms are Merck and Co. and Sharp and Dohme.

Preparatory to the setting up of the two units mentioned, the committee found it necessary to provide an analysis of the chemical literature of the morphine derivatives for the use of American students, especially for the use of the students in the laboratory for alkaloid chemistry at the University of Virginia. Dr. Small has prepared this for publication and the United States Public Health Service has agreed to publish it as a bulletin. A similar analysis of the literature of the biological action of morphine derivatives is being prepared for the use of the laboratory at the University of Michigan by Dr. R. A. Hatcher, professor of pharmacology at Cornell University Medical School.

Such analyses are necessary in order that the group of workers in each university may proceed with their problems without the necessity of individually spending their time studying the literature.

The second avenue of approach adopted by the committee that might prove of some assistance in the problem of drug addiction was to present accurate information concerning the necessary uses for which addiction-producing drugs should be employed. The committee felt that if it could present these necessary uses to the medical profession, with suggestions for the substitution of non-addiction drugs in cases where the latter would serve equally well, the use of addiction-producing drugs might be considerably reduced. Articles to present this information are being prepared by the American Medical Association in conjunction with the National Research Council by Dr. Fishbein and a group of skilled writers to be published in the *Journal of the American Medical Association.*

Graduate students interested in alkaloid chemistry or the physiological action of alkaloids will find opportunity for such study at the University of Virginia and the University of Michigan.

WM. CHARLES WHITE,
Chairman, Committee on Drug Addiction

AMERICAN SCHOOL OF PREHISTORIC RESEARCH

THE tenth annual session of the American School of Prehistoric Research opened in Paris on July 1, and closed in Prague on September 3. Twelve students—ten men and two women—all but two of them graduate students, were enrolled: Lloyd Cabot Briggs, Harvard University; Miss Jeanne Ernst, Mount Holyoke College; John P. Gillin, University of Wisconsin; Robert F. Greenlee, Northwestern University; Theodore D. McCown, University of California; Robert H. Merrill, University of Michigan; John Z. Miller, Lehigh University; Panchanan Mitra, Yale and the University of Calcutta; Cornelius B. Osgood, University of Chicago; Froehlich G. Rainey, University of Illinois; Miss Lucile Serrem, Columbia University; Sol Tax, University of Wisconsin. J. Townsend Russell, Jr., a former student of the school, assisted the director, who also had the assistance of two other former students after the group reached Czechoslovakia, *viz.*, V. J. Fewkes, of the

University of Pennsylvania, and Robert W. Ehrich, of Harvard University.

The itinerary included parts of France, Spain, Switzerland, southern Germany and Czechoslovakia. Digging was done in three sites, representing various culture levels: thirteen days in the Abri des Merveilles (Dordogne), with three horizons—two Mousterian and one Aurignacian; three days in the cavern of El Pendo (Prov. Santander), Spain, with four horizons—Mousterian, Solutrean, Magdalenian and Azilian; and seven days at Homolka, near Prague, with late Neolithic and early metal cultures.

This gave the students a wide range of experience not only in the art of digging, but also practice in the determination of specimens from various epochs as well as from various phases of a given epoch. It was our good fortune at El Pendo to help in the discovery of two works of art dating from the Magdalenian Epoch—a stag engraved on bone and a horse, likewise engraved on bone.

The actual digging was supplemented by visits to fifty prehistoric sites representing practically every phase of prehistory and by the study of museum and private collections. Coincident with the diggings and the visits to sites and museums, forty-two conferences were given—eleven by the director and thirty-one by foreign specialists and by certain of the students. For these conferences we are indebted to the Abbé Breuil, Harper Kelley, Z. Le Rouzic, G. Chauvet, Étienne Patte, Count Begouen, Louis Begouen and D. Peyrony, in France; Carballo in Spain; D. Viollier and Emil Bächler in Switzerland; F. Birkner and K. Hörmann in Germany; and J. Schranil and J. Skutil in Czechoslovakia. The students who gave conferences were Greenlee, McCown, Merrill and Tax; a former student—Fewkes—also gave conferences.

Toward the end of the term, thanks to the assistance of Russell, Fewkes and Ehrich, it was possible for Mrs. MacCurdy and myself to remain behind in France in order to make a prehistoric pilgrimage through France and Spain with General Charles G. Dawes, our ambassador to Great Britain, who met us in Périgueux on August 23 and remained with us until the end of the month. At the same time there also joined our party Mr. Addison L. Green, chairman of our board of trustees, and his son, Marshall Green. We visited the principal prehistoric sites of the Vézère Valley; then went to northern Spain to see the cavern of Altamira and the prehistoric museum in Santander. In Madrid, we visited the Archeological Museum and the Museum of Natural History; and in Seville, the Archivo de Indias. From Seville, we made a two-day excursion to the museum at Niebla, the dolmen de Soto, and the prehistoric copper mines at Rio Tinto.

During the spring months our school dug jointly with the British School of Archaeology, Jerusalem, at the cave of the valley near Athlit, and south of Haifa, Palestine. This was our second season at this site. Miss Dorothy Garrod, representing the British school, was again in charge; our two representatives were Dr. Martha Hackett, of Mount Holyoke College, and Theodore D. McCown, of the University of California. This second season's excavations yielded some 20,000 specimens dating from the Mousterian, Aurignacian, Mesolithic and later epochs. Joint excavations will be resumed here during the spring of 1931.

In March, 1930, there was published *Bulletin* No. 6 of the School (43 pages), containing the director's report and Miss Dorothy Garrod's paper entitled: "The Paleolithic of Southern Kurdistan," which describes the joint explorations and excavations of our school and the Percy Sladen Fund (British) during the autumn of 1928.

GEORGE GRANT MACCURDY

YALE UNIVERSITY,
NEW HAVEN, CONNECTICUT

SCIENTIFIC APPARATUS AND LABORATORY METHODS

TWO IMPROVEMENTS IN THE TECHNIQUE OF KYMOGRAPH RECORDING

1. THE use of the pressure air gun for applying carbon particles in suspension in the place of smoking to blacken the recording surface.

2. The use of transparent cellophane in place of glazed paper as a recording surface.

(1) In many respects the time-honored procedure of preparing kymograph paper for use by "smoking" is a very unsatisfactory one. The unevenness of the resulting surface, particularly when natural gas is used in the smoking burner, the inconvenience in operation and smudginess of the smoking arrangements, and the inadaptability to other surfaces than glazed paper are perhaps the most serious difficulties. It has been found possible to obviate these and other difficulties by applying a suspension of fine carbon particles in a suitably volatile vehicle, sprayed on to the recording surface with an air gun. The following procedures have been found advisable in the preparation and application of the carbon suspension.

a The vehicle should be sufficiently volatile to just wet the surface slightly. If put on too dry the impact of the jet tends to remove some of the already

deposited particles. It must have a specific gravity approximating that of the carbon particles to be suspended in it in order to prevent rapid settling out. These requirements are rather well met by carbon tetrachloride. The cost of carbon tetrachloride being high, some of the heavier commercial hydrocarbons were used successfully, such as Union Oil Company's Cleaning Naphtha with a Baumé gravity of 55 and an initial and end boiling point of 95 to 145° C., respectively. Gasoline is not satisfactory, as the end point is too high.

b As a source of carbon particles of suitable size, the better brands of lamp black (vegetable black) have been found to be satisfactory. Some ten other kinds of black pigment were tried unsuccessfully. Sixteen grams of vegetable black per liter of fluid are taken, and the mixture shaken vigorously for five or ten minutes. This can be done most conveniently in a mechanical shaker. Grinding in a ball mill or deflocculating in a colloid mill would improve the suspension, but is not a necessity. The suspension is strained through as fine a mesh cloth as possible and stored in pint Mason jars, of the type fitting the pressure gun to be used. When the suspension is stored it must be shaken vigorously prior to use.

c In applying the suspension any well-designed spray gun in which the air issues from an annular orifice surrounding the fluid nozzle would probably be found satisfactory, but the cheaper makes of gun are to be avoided. We have used the "Sharpe" pint-size gun successfully at ten to twenty pounds air pressure. In applying the black it has been found advisable to rotate the drum rapidly on an upright shaft at a distance of 20 to 40 cm from the nozzle of the spray gun. At this distance the naphtha will not wet the surface of the drum excessively, providing the needle valve regulating the mixture of air and fluid is properly set. The spray gun should be shaken occasionally to prevent settling of the carbon. In this manner a thin, uniform coat of carbon particles can be applied quickly and conveniently to the recording surface. Too heavy a layer should be avoided in the interests of diminishing friction of recording levers and of preventing the washing of the carbon in the fixing process after records have been made. An enclosed exhaust booth is a necessity where a large amount of spraying is done. There is nothing critical in the above process and reasonable variations may be individually made.

(2) *A very great simplification and improvement* in the photographic reproduction of kymograph tracings has been found to be possible by the use of transparent recording material in place of glazed paper. The difficulties of photographic reproduction of varnished kymograph tracings are too well known, and too obvious from the many poor reproductions found in the scientific journals, to need emphasis. We have found it to be simple to avoid these difficulties by direct printing from fixed cellophane records. Colorless, transparent No. 600 cellophane sheets used in place of kymograph paper make a satisfactory recording surface. Cellophane can not conveniently be blackened by smoke and is best prepared for recording by the spray-gun method just described. After records have been made the surface can be fixed by passing the strip through a bath of carbon tetrachloride containing 3 per cent. rosin (the latter put into solution by prolonged mechanical shaking).

The record thus fixed can be used directly for printing positives, in which the graphic records stand out in black against a white background. Direct enlargements up to twenty times have been made retaining sharp delineation, and offer possibilities for closer study of certain phenomena (in our studies particularly isometric tension curves). Direct reduction is also highly successful and is desirable in printing upon lantern slides and in illustrations for publication.

It should also be noted that segments of the original fixed record can themselves be successfully used in making lantern slides by simple mounting between blank glass slides.

Transparent cellophane, No. 600, in strips 7 inches wide, rolled, has been supplied at our request by the E. I. du Pont de Nemours Company, and is priced at such a figure as to make its use more economical than that of glazed paper.

W. F. WICHART
C. H. THIENES
M. B. VISSCHER
UNIVERSITY OF SOUTHERN CALIFORNIA

USE OF ETHYLENE OXIDE FOR THE ERADICATION OF PESTS

THE barberry eradication campaign as well as the campaigns for the control of white pine blister rust through the eradication of currants and gooseberries have shown the need of a chemical substance with high toxicity to the plants, yet which will have no lasting detrimental effect on the soil. The practice of digging barberry bushes leaves a possibility of sprouts being produced from pieces of roots not found in digging. The use of common salt is a more desirable practice from the standpoint of the labor involved and the effectiveness of the killing agent. For use in pastures this method may have some objection. The use of chlorates, arsenates, etc., is excluded in pastures where cattle may be poisoned.

Some observations made by Vacha and Harvey[1] indicated a high toxicity of ethylene oxide to plant tissues. More recent work by the author has shown that ethylene oxide has many properties which make it suitable for killing noxious plants. By the use of a rod it can be introduced into the soil beneath the bushes. The "depth charge" can be regulated to certain levels of roots in the soil. The materials injected are not accessible to animals. Ethylene oxide is liquid at ordinary temperatures at pressures between eight and twenty pounds per square inch. This gives pressure sufficient to drive it into the soil directly from the tank. A special measuring device fitted to an injecting rod has been devised, which may be called a "gopher stick." Such a device is of use also in killing gophers by similar toxic agents. The ethylene oxide is volatile enough to allow a quick spread through the soil and a relatively short period of its effect in the soil. It is soluble in water, and dilutions with ice-cold water can be made with little loss when it is desired to use a water dilution or a mixture with other toxic agents. Dilutions can be handled in the usual knapsack sprayer with a "gopher stick" in place of the spray nozzle. Mixtures with chlorates or formaldehyde may be used without chemical reaction destroying the toxicity.

The ethylene oxide penetrates quickly up through the tissues, causing marked discoloration of the leaves within a few days. The effect in sterilizing the tissue through which it passes is being investigated since it may be of use in killing fungi or insects within the wood or bark to prevent their dissemination. The use of such a penetrating sterilizing agent would decrease the labor of removing trees which are infected with such pests.

The use of ethylene oxide alone and in water solution has been shown by the killing of several hundred bushes of barberry,[2] currant, gooseberry, poison ivy, prickly ash, scrub oak, popple, boxelder, etc. The size of the charge or dose must be adjusted to the bush to be eradicated. Determinations have been made on the charge required in different types of soils and with various soil moisture contents. Indications are that at the present price of ethylene oxide the cost of materials is about the same as for eradication by common salt while the labor is considerably reduced. Other oxides of the unsaturated hydrocarbon series are being tried for their toxicity and effectiveness.

RODNEY B. HARVEY
LABORATORY OF PLANT PHYSIOLOGY,
MINNESOTA AGRICULTURAL EXPERIMENT STATION

[1] *Plant Physiology*, 2: 187–193, 1927.

[2] The author is indebted to Dr. L. W. Melander and the Office of Barberry Eradication, U. S. Department of Agriculture, for cooperation and assistance in the experiments.

SPECIAL ARTICLES

THE BIOLOGY OF THE PETROLEUM FLY

RECENTLY a well-known systematic zoologist, Dr. W. T. Calman,[1] gently admonished physiologists for their tendency to neglect "the unending diversity of structure and habit among animals" and emphasized the danger of making far-reaching generalizations from experiments carried out upon the still somewhat restricted fauna of the physiological laboratory. In no group in the animal kingdom are such generalizations more unsafe than in the Insecta, for nowhere is physiological diversity more marked. And perhaps no insect is more aberrant physiologically than the petroleum fly.

Considering the fact that the existence of this insect has been known to entomologists for over thirty years, it might be thought that all the details of the life history and physiology would have been described long ago. Owing perhaps to the restricted distribution (it appears to be confined to the oil-fields of S. California) this is far from being the case, and although some of the main facts of its structure and life history have been described by Howard[2] and Crawford[3] there still remain many points of interest to be investigated. The subject is one of interest not only to the entomologist but also to the physical chemist and general physiologist, for, as is well known, paraffin hydrocarbons, owing to their power of rapidly penetrating cell membranes, are highly toxic to living tissues.

The writer had the opportunity while working at the Citrus Experiment Station of the University of California at Riverside in 1928 and 1929 of investigating certain matters concerning the nutrition of this insect and its adaptation to a life in oil. The main results of these investigations are here summarized. Full details of the experiments will be published shortly.[4]

The larvae of *Psilopa petrolii* go through their entire development in shallow pools of waste oil, breath-

[1] W. T. Calman, presidential address, Section D—Zoology, British Association for the Advancement of Science, 1930.

[2] L. O. Howard, *Scientific American*, 80: 75, 1899.

[3] D. L. Crawford, *Pomona College Journal of Entomology*, 4: 687–697, 1912.

[4] *Trans. Ent. Soc. Lond.*, 1930.

ing by means of the posterior spiracles which they can project above the surface of the oil at will, each spiracular process being supported by four fan-like structures which rest upon the surface film and which are closely similar to those found in many aquatic ephydrid larvae. The oil is the residue left when the more volatile elements, such as gasoline and petroleum naphtha, have evaporated off. Tests kindly carried out for me by Dr. R. H. Smith showed that at 310° C. only 10 per cent. of the oil had distilled over.

Howard[2] naturally assumed that the larvae must feed on the remains of insects or other organisms caught in the viscous oil, but some doubt was thrown on this by certain experiments carried out by Esterley and described by Crawford,[3] who reported that young larvae could be reared to maturity in filtered sterilized oil without any extraneous organic matter—the inference being that they could derive their energy from the digestion of hydrocarbons! The variety of digestive powers among the insects is well known, but such an astonishing conclusion as this seemed to demand further investigation.

By keeping the larvae in pure, transparent medicinal paraffin it was soon found that they readily devoured small pieces of animal tissue, and in this medium their exact method of doing so could easily be observed. But experiments were undertaken to test the matter further.

Sixty young larvae were placed singly in tubes each containing a small quantity of the natural oil which had been filtered through fine cloth by means of a suction pump. To thirty of these tubes was added every three days a small piece of a crushed tuber-moth larva, the larvae in the remaining tubes being starved. Of those which received food, 50 per cent. pupated and 33 per cent. emerged as adults, whereas none of the starved larvae lived to maturity. In another experiment in which 180 larvae were reared in filtered oil in petri dishes in lots of ten, the results were:

	Per cent. pupated	Per cent. emerged as adults
Oil alone	6.3	1.8
Oil plus food	53.0	41.4

and similar results were obtained from other experiments. It was found that the figures in the first line were due to the cannibalistic tendencies of these larvae when starved, those that die providing sufficient food material to bring a small percentage to maturity, and since details of Esterley's experiments have never been published and are not available, we must assume that this is the explanation of his results.

We may conclude then that the larvae can not develop without extraneous organic matter, and there is little doubt that under natural conditions small insects trapped in the sticky oil are the chief source of food. That they derive no nutriment at all from the oil is more difficult to prove, but experiments with a variety of oils of different composition gave no suggestion that they are able to do so. It was, however, interesting to find on sectioning that the hind gut contains enormous numbers of bacteria-like bodies. Without fresh material it is unfortunately not possible at present to identify them with certainty, but stained with Murray's toluidine blue—Van Gieson, they have the appearance of a coccobacillus. They are Gram-positive and approximately 1 μ in length, and are often present also in the mid gut within the peritrophic membrane, although always in much smaller numbers. What part, if any, these organisms may play in the processes of digestion it is at present impossible to say.

The Ephydridae is a group the larvae of which are characterized by ability to live in a variety of unusual situations—brine, alkaline waters, urine, etc. This ability appears to be due to the presence of a very impermeable cuticle and a very efficient mechanism of hairs and bristles protecting the spiracular openings. It is very largely by the same means, and *not* by any tolerance of the tissues themselves to hydrocarbons, that the petroleum fly is enabled to exist in its extraordinary environment. Experiments with various lighter and more volatile oils which are able to enter the tracheal tubes as vapor and condense as a film upon the walls, thus overcoming the protective mechanism, show clearly that when once the oil enters the tracheal system the toxic hydrocarbons are absorbed and, having got into contact with the tissues themselves, are as poisonous to the petroleum fly as to any other insect.

The impermeability of the general cuticle of the larva to substances usually regarded as highly penetrating is well shown by its resistance to fixatives; for instance, the larva will remain active in strong alcoholic picro-formol (Bouin's fluid) for twenty minutes. But why is it that the oil does not reach the tissues by absorption through the walls of the alimentary canal, which is filled with oil from end to end? The answer is that the oil never gets into contact with the gut epithelium at all. The fore and hind guts of course are protected by a chitinous layer, and in the mid gut there is the peritrophic membrane. The latter is well developed, as is the case with most cyclorrhaphous larvae, and from dissections it seems that the oil itself does not actually pass through the peritrophic membrane. The characteristic dark color of the oil is seen only within it, the region between the mem-

brane and the digestive epithelium, as well as the latter itself, being clear and unstained. Moreover, the wall of the mesenteron can be dissected away without difficulty, leaving intact the tough peritrophic membrane with its oily contents.

It might be thought that the water supply would be an acute problem for an animal living in such a medium, but this is not so, for distillation tests reveal that there is a considerable amount of water contained in the oil in the form of minute droplets, and, moreover, in many cases the oil pools overlie shallow pools of water, those most frequented by larvae being those in which there is no great depth of oil.

One would have imagined that an animal living in oil would be immune from the attacks of parasites, and it is interesting to find that a protozoan has been able to follow its host into such an environment. Certain of the epithelial cells of the mesenteron are seen in section to be distended with spores of a sporozoan parasite, apparently a microsporidian, the nucleus often being pushed to one side by the mass of spores. These bodies are approximately 4 μ in length and stain very intensely with toluidine blue, hematoxylin and methyl blue-eosin, the multinucleate nature of the spore being most clearly seen with the latter stain. Lack of material exhibiting further stages in the life history has so far prevented closer identification.

It is a remarkable thing that *P. petrolii* should exhibit no structural peculiarities correlated with its unique mode of life. With the possible exception of the unusually great muscular development which enables the larva to swim actively in such a viscous medium there are no *essential* morphological differences between the petroleum fly and a typical aquatic ephydrid. Such adaptations as must have occurred are physiological rather than morphological and are of a puzzling nature. What, for instance, can be the peculiarity about the spiracular structures which prevents the oil from spreading into them? Possibly the peristigmatic glands yield an aqueous secretion in place of the more general waxy or oily substances. Similarly, what substance can be produced by the glandular hairs of the tarsus of the adult fly which enables it to walk on oily surfaces which will entangle other insects almost immediately? Again what can be the change which must have taken place in the composition of the digestive juices to enable them to act upon food saturated with petroleum? These are the problems which concern the biochemist and the physical chemist rather than the entomologist, and appear to the writer to have a very considerable theoretical interest.

W. H. Thorpe

Imperial Institute of Entomology,
England

THE MORPHOLOGICAL BASIS FOR CERTAIN TISSUE RESISTANCE

Tissue resistance against bacterial invasion generally finds an explanation in the production of specific bactericidal and antitoxic substances on the part of the organism or in the increased activity of certain wandering cells of the infected host. The resistance which may develop in the higher animals against certain drugs and chemical poisons can not be explained by any of the above-mentioned mechanisms.

The fact has been known for many years that when either the acetate or the nitrate of uranium is given subcutaneously to dogs they develop an acute experimental nephritis in which the injury to the kidneys is at first, in so far as structural changes are concerned, very largely confined to the epithelium of the proximal convoluted tubules. Suzuki,[1] working in Aschoff's laboratory, was of the opinion that this acute injury was confined to the epithelium in certain segments of these tubules.

In a recent Harvey Lecture[2] and in two investigations[3,4] which formed the basis for the experimental data presented in this lecture, a discussion was undertaken of the toxic effect of uranium on the kidney and the mechanism of repair in the injured kidney, and certain observations were presented relative to the resistance which the kidney, the seat of a chronic uranium injury, developed against subsequent acute injuries from the same nephrotoxic substance.

During the past two years these studies have been continued by using repeated injections of uranium with the object in view of obtaining more evidence regarding the morphological changes developing in the kidneys which give to them both a structural and functional resistance to this poison. These experiments have been conducted by first anesthetizing normal dogs and removing from the left kidney a small wedge-shaped piece of tissue which, in its study, has served as the normal control for the acute and chronic changes developing in the kidneys fol-

[1] T. Suzuki, "Morphologie der Nierensekretion," Jena, 1912.

[2] Wm. deB. MacNider, "Urine Formation during the Acute and Chronic Nephritis Induced by Uranium Nitrate," *The Harvey Lectures*, 1928–1929.

[3] Wm. deB. MacNider, "The Development of the Chronic Nephritis Induced in the Dog by Uranium Nitrate. A Functional and Pathological Study with Observations on the Formation of Urine by the Altered Kidneys."

[4] Wm. deB. MacNider, "The Functional and Pathological Response of the Kidney in Dogs Subjected to a Second Subcutaneous Injection of Uranium Nitrate," *Jour. Exp. Med.*, XLIX, 411, 1929.

lowing a series of intoxications by uranium. Prior to such operative interference the functional value of the kidneys has been ascertained by the use of the phenolsulphonephthalein test for renal function, by determinations of blood urea, blood non-protein nitrogen and creatinine, and by estimating the reserve alkali of the blood. Following the subcutaneous injection of uranium in normal dogs and also in animals with a chronic renal injury from such injections, kidney tissue has been removed for microscopic study and observations have been made on renal function by the methods just indicated.

When a solution of uranium nitrate is given subcutaneously to dogs in the dose of from 2 to 4 mgs per kilogram the animals show an initial increase in the formation of urine, which is albuminous, a decrease in the elimination of phenolsulphonephthalein, a reduction in the reserve alkali of the blood, and a commencing retention of blood urea and non-protein nitrogen which is later followed by a retention of creatinine. Kidney tissue removed from such acutely nephritic animals has shown the characteristic uranium injury which anatomically is localized in the epithelium of the proximal convoluted tubules. The cells in this location have become edematous and vacuolated and have shown varying degrees of necrosis. The majority of animals with this type of acute renal injury effect either a partial or a complete functional recovery. On this basis they may be divided into two groups. In Group I, represented by animals with a return to a normal renal function, kidney tissue which has been removed has shown but slight evidence of injury to the vascular tissue of the organ. In the convoluted tubules, the seat of the initial selective epithelial injury, there has developed a process of repair consisting in a relining of these tubules by cells similar in configuration to those normally present in this portion of the tubule. These cells have their origin from convoluted tubule cells which have not been killed by the acute injury from uranium. When the animals of this group (Group I) that have effected a normal type of epithelial repair are given a second subcutaneous injection of uranium nitrate in an amount per kilogram similar to the first injection, they show no evidence of having acquired any tolerance or resistance in so far as the nephrotoxic action of the poison is concerned. This lack of protection in the kidney against uranium is indicated functionally by the development of a marked albuminuria, a reduction in the reserve alkali of the blood, a decrease in the elimination of phenolsulphonephthalein, and a retention of urea, non-protein nitrogen and creatinine. Animals of this group rarely survive a second injection of the poison. The histological study of renal tissue from such animals shows a repetition of the acute epithelial injury in the convoluted tubules. The regenerated cells of the normal type in this segment of the tubule become edematous and necrotic.

The animals falling in Group II are represented by those dogs which, after having developed an acute renal injury from the primary injection of uranium, failed to establish a complete restoration in renal function. They have shown such changes in the blood and urine with such pathological alterations in the kidneys as to enable them to be classified as animals with a chronic nephritis. The evidence of a partial restoration in renal function by the dogs of this group is found in the very greatly diminishing amount of albumin in the urine or its entire disappearance, by an increase in the ability of the kidney to eliminate phenolsulphonephthalein, by a return of the reserve alkali of the blood to the normal, and by a decrease in the retention of urea, non-protein nitrogen and creatinine. The histological study of renal tissue from the animals of this group, after they had established their functional pathological normal, shows that connective tissue changes varying in degree have taken place in the vascular tissue of the kidney. These changes are of the same type but are more advanced in their development than similar changes occurring in the animals of Group I. The striking difference which has taken place in the processes of repair in the kidneys of animals of Group II which separates them anatomically from the animals of Group I is to be found in the restoration of cells in the proximal convoluted tubules. The repair to the epithelial damage in these tubules has taken place by their relining with a type of cell morphologically different from normal proximal convoluted tubule epithelium and therefore different from the type of cell which was regenerated in these tubules in the animals of Group I. The repair process of the tubules in the animals of Group II which have failed to return to a functional normal has consisted in an ingrowth into the tubules of a flattened, non-specialized type of cell or by an ingrowth of an undifferentiated syncytial layer of cell substance containing large, deeply-staining nuclei. Mitotic figures are frequently found in either type of epithelial replacement.

The animals of Group II have been used for subsequent uranium injections, as was the case with the animals of Group I. When the animals of this latter group were given a secondary injection of 2 or 4 mgs of uranium per kilogram, they were found to have developed a definite resistance to its toxic effect in so far as this action was expressed by a functional renal disturbance. The amount of albumin appearing in

the urine was definitely less than that occurring from such secondary injections in the animals of Group I. The reduction in the elimination by the kidney of phenolsulphonephthalein was not so great, the reserve alkali of the blood was usually undisturbed, there was no retention of creatinine, and the retention of both urea and non-protein nitrogen was slight or failed to occur. In six dogs with a partial restoration in renal function from an initial uranium injection, the amount of uranium has been increased from the primary dose of 2 mgs per kilogram to 8 mgs and in each instance the same type of modified nephrotoxic action has been obtained.

The morphological basis for this resistance on the part of the kidney to uranium has been associated with the type of epithelial repair to the convoluted tubules and the extent to which this repair has taken place. Those animals with a chronic nephritis in which the epithelial replacement has been very largely effected by a relining of the tubules with a flattened, non-specialized type of cell, have shown functionally the highest tissue resistance against repeated intoxications by uranium. This type of cell is resistant to the toxic action of the poison. It fails under its influence to become edematous and necrotic.

These experiments would not indicate the acquisition on the part of the animals of an immunity to uranium, but the substitution in the kidney, as a result of a process of repair, of a type of epithelial tissue atypical for the convoluted tubules, which either fails to secrete uranium and subject itself to an injury from the substance, or an epithelium which is resistant to it during secretion. Such changes in cell types in the kidney may be looked upon as a morphological defense mechanism giving to the organ an acquired tissue resistance which varies in degree for subsequent injuries from the same chemical substance.

WM. DEB. MACNIDER
UNIVERSITY OF NORTH CAROLINA

A NEW FACTOR IN THE TRANSPORTATION AND DISTRIBUTION OF MARINE SEDIMENTS

ONE of the well-known facts concerning the distribution of marine sediments on the continental shelves is that there is a progressive gradation from coarse to fine-grained material away from the shore. The mechanism of the sorting power of the sea and its ability to transport material still remain an unsolved problem of the sedimentationist. Many explanations have been put forward as to the action of currents in the sea produced by tides, winds and differences in density, but no observational data have been accumulated to give us any definite knowledge of the method by which grains of sand and silt are actually transported. With the object of making an investigation of this subject, Mr. Stetson devised a trap which could be placed on the sea bottom in such a way as to catch particles which were traveling in suspension within a few inches of the sea floor. The traps are boxes of heavy galvanized sheet iron 1 foot 2 inches square in ground plan, with the sides bent in and sloping up to a central opening 8 inches square. In some cases the trap was constructed with the lip 1 inch from the bottom, in other instances 6 inches. The deeper traps seem on the whole to be the more satisfactory. Two half doors hinged in the middle were fitted to the opening, which could be tightly closed by a messenger dropped from the surface before the apparatus was hauled up. It is planned to place a series of these traps along a profile on the continental shelf, with the hope of obtaining from them some knowledge of when, and possibly how, the grains travel.

Among the first results of the preliminary work with the traps has been to find, on hauling the first of them after it had been a week on the bottom in about eight fathoms of water, approximately a half mile east of the sandy bluff known at Fourth Cliff, Scituate, that it contained a layer 2 inches deep of a jelly-like substance concerning which little or nothing seems to be known. This jelly is practically colorless, and, when examined under the microscope, also structureless. In it are found grains of sand and silt, fragments of eel grass and fucus, much macerated particles of various algae, shells of diatoms and foraminifera, and small spicules of various sorts. The origin and composition of the jelly are a subject for investigations which are now being carried out. The late C. G. Joh. Petersen investigated the organic matter in the waters off Denmark, and found at the bottom a layer from one to three mm in thickness, composed largely of organic matter, which on account of its color he called the brown layer. He also found in certain localities what he spoke of as mud which quivered like jelly. The material he found seems to have been very much like the jelly in our trap. Petersen's studies, summarized in the report of the Danish Biological Station, Vol. XX, 1911, led him to the conclusion that the material with which he was dealing was made up principally of decomposed vegetable matter, the chief contributor being eel grass. Another suggestion is that the material might be sewage, but it is seemingly too abundant and too widely distributed to be so explained.

A survey of the distribution of this material has been carried on, using a scraper dredge. Several lines of stations were run, beginning at the beach and going off shore about ten miles, with bottom samples taken about every mile. The places selected were the south

shore of Massachusetts Bay from Marshfield to Cohasset, and the southern half of Ipswich Bay north of Cape Ann, because in both these regions the profile of equilibrium appears to be well developed. The jelly was found in every haul and on every sort of bottom. In the shoal water near shore, 20–150 feet deep, much fresh material is present, that is, the plant fragments are still identifiable. The entangled sand grains here range as high as fine beach sizes. The mud zone on the Massachusetts coast begins at a depth of about 225–300 feet. From a depth of 200 feet outward, the jelly was a homogeneous mass in which the organic detritus can not be identified. Some of the fresher material taken near shore was allowed to stand about four months in sealed jars. At the end of that time, the plant fragments had rotted down so that the jelly resembled that found in the mud zone. The sediment collected at 350 feet of depth, which was the deepest taken, ranges from clay and silt sizes to very fine sand. A bottom core, five feet long, taken at this depth in Ipswich Bay, shows about 10 per cent. fine white sand, and the rest clay and silt. It is homogeneous in composition for its whole length.

As might be expected, there seems to be a definite relationship between rough and calm weather and the condition of the jelly. During periods of calm the very top of the jelly layer flocculates and collects in light feathery masses. After a period of rough weather the entire layer is churned up and samples taken at such a time present on settling a much more uniform and compact appearance. Further settling of the very fine particles again produces the flocculent appearance of the top layer. This condition may be duplicated by violent agitation in a jar in the laboratory.

The transporting power of this jelly is further illustrated by the fact that during and after every storm it may be taken, with its entangled sand, from surface water. The roiling, so noticeable in coastal waters after every storm, is probably due in a large measure to this jelly and not to free sediment. The day after a 60-mile easterly gale, three gallons of surface water were taken off the entrance to Cohasset harbor in 25 feet of water. This position is protected from the full sweep of the seas by a string of ledges a mile or more off shore. After filtering and washing with fresh water, the sample was ignited to remove the organic material. .2604 gram of actual sand and silt remained. The largest sizes are included in Wentworth's "very fine sand" class with sizes ranging from 1/8–1/16 mm. These grains are largely quartz. It is obvious that if this amount of sediment was in suspension at the surface, greater quantities would be encountered near the bottom. The total carrying capacity must be enormous. This may explain in a large measure the rapid silting of harbors and estuaries; it enables sediment to travel along the bottom and in suspension in a current the velocity of which would otherwise be powerless to move it. On the day in question the flood tide entering Cohasset harbor was so muddy with jelly that an object two feet below the surface was invisible. The ebb was noticeably clearer.

The main significance of this material, whatever may be its origin, lies in its obvious importance as an agent in the transportation of sand grains. Samples of the material dried and weighed after the combustion of the organic matter shows that about 85 per cent. by weight consists of grains of various sizes, from fine sand to silt. Since only the slightest amount of current is necessary to transport this jelly, it could be widely and easily distributed without evoking the aid of any strong currents near the sea bottom.

If Petersen is correct in his contention that most of the organic matter in the coastal waters is decomposed eel grass, then there is a periodicity in transportation. Eel grass being a deciduous plant, the new supply of vegetation is an annual product, the decay beginning with the shedding of the leaves in the fall. The thin brown layer which Petersen found in large areas of the sea bottom around Denmark is believed to be decomposed eel grass which had come to rest below the wave base. It is, therefore, possible that since heavy storms are likewise seasonal, the jelly may have another significance in that it may possibly form parting planes, and in some places at least may happen to be buried and produce the appearance of varves, which is not infrequently observed in marine strata. It seems more probable that eel grass is only one of its constituents and that algae probably play a large part. The chemical analysis is now being carried out, and next summer a survey of its distribution will be made in the Gulf of Maine and adjacent waters.

PERCY E. RAYMOND,
H. C. STETSON
HARVARD UNIVERSITY

BOOKS RECEIVED

GEE, WILSON. *The Place of Agriculture in American Life*. Pp. vii + 217. Macmillan. $2.00.

JENKINS, GLENN L., and ANDRE G. DUMEZ. *Quantitative Pharmaceutical Chemistry*. Pp. xxiii + 408. McGraw-Hill. $2.50.

KENDREW, W. G. *Climate*. Pp. ix + 329. Oxford University Press. $5.00.

NEEDHAM, JAMES G. *A Manual of the Dragonflies of China*. Pp. 344. Fan Memorial Institute of Biology, Peking Society of Natural History.

THOMAS, TRACY. *The Elementary Theory of Tensors*. Pp. ix + 122. McGraw-Hill. $2.50.

WILLCOX, OSWIN W. *Principles of Agrobiology*. Pp. 96. Palmer. $4.00.

SCIENCE

VOL. LXXIII — FRIDAY, JANUARY 30, 1931 — No. 1883

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

RECENT DEVELOPMENTS IN PHOTOELECTRICITY[1]

By Professor C. E. MENDENHALL

UNIVERSITY OF WISCONSIN

THE general quantum theory may be said to have been born of a black body and sired by the photoelectric effect. Consequently, since we are all, willy-nilly, quantists, every one has at least a genealogical interest in photoelectricity. For some, this interest is enhanced by a certain fascination of the phenomenon itself, and just at present the relation of experiment to statistical and wave-mechanical theory is attracting particular attention. While it is my purpose to discuss mainly recent aspects of the subject, though with no attempt at completeness, it will be useful for the sake of clarity to restate very briefly certain of the earlier generalizations, in order that the later material may be placed in proper relation to them.

The term photoelectricity covers what are, from the standpoint of technique at least, two distinct fields, the "external" and "internal" effects, the latter being sometimes more descriptively called "photo-conductivity," and it is with the former only that we shall be concerned. Furthermore, the "external effect" itself involves two sets of phenomena, which are experimentally and theoretically quite distinct, according as the matter from which electrons are being removed is in the one case a vapor or in the other case a solid or liquid.

The case of a vapor is obviously the simplest, but it has been the last to be developed because of experimental difficulties. The Bohr theory led one to expect that if the energy of the light quantum equalled or exceeded the ionization energy of the atom, or molecule, ionization would result, and experiments of Williamson, Lawrence and others have verified this and given values of the ionization potential consistent with other determinations. On account of the difficulty of working with sufficiently short wave-lengths,

[1] Address of the retiring vice-president of Section B—Physics, American Association for the Advancement of Science, Cleveland, December 31, 1930.

photoelectric measurements of ionizing potentials have been carried out only with the vapors of the alkali metals. However, a repetition of some early work of Steubing's carried out with very considerable improvements by Rouse and Giddings has led to a considerable study of what might be called secondary phenomena, namely, ionization in what were thought to be monatomic vapors by light whose quantum value is *less* than the energy necessary for ionization —in some cases not half the necessary amount. In the case of mercury and cadmium the atomic absorption of the resonance line, resulting in excited atoms, is the primary action, and *two* such excited atoms are necessary for ionization. In the case of the alkali metal vapors, as studied by Foote, Lawrence and Edlefson, and Mohler and his coworkers, not only does absorption in the atomic series lines produce ionization, but there is a continuous background of absorption of wave-lengths longer than the ionization limit, which also results in ionization. The most probable explanation of all such cases involves a suggestion of Franck's that the ions observed are molecular, though no direct confirmation of the presence of such ions has yet been made by measurements of $\frac{e}{m}$. In the case of mercury and cadmium the molecules are probably formed by the combination of two excited atoms. In the case of caesium, Mohler and Boeckner conclude that neutral molecules are initially present either in the normal or in some vibrational state—the range of vibrational states present accounting for the range of wave-lengths longer than that corresponding to the ionization of the normal molecule, which will actually produce ionization. This type of photoelectric effect thus leads one at once into the theory of molecular structure and of impacts between molecules and atoms. In the hands of Mohler and his coworkers it has proved a very sensitive means for studying the distances involved in such collisions as dependent on the excited states of the atoms, as well as the mean life of these states.

Turning now to the photoelectric discharge from solids and liquids, the problem is of course entirely different and molecular and atomic theory has not yet come to play a part in it, though there are some very puzzling empirical correlations between photoelectric quantities and atomic constants. The earlier generalizations can best be summarized by Einstein's two famous equations, which not only correlated the facts so beautifully, but gave to the young quantum theory an aspect of much greater physical reality. These equations are:

$$U = 1/2\, m \cdot v^2_{max} = h\nu - e\varphi = h(\nu - \nu_0)$$

$$N = \frac{Q}{h\nu} = \frac{Q\lambda}{hc}$$

where U is the *maximum* energy of the electrons after emission due to light of frequency, ν, ν_0 is the low frequency limit, N is the number of electrons emitted by the *absorbed* light energy Q, λ is the wave-length corresponding to ν v_{max} is the maximum electron velocity, and h is the Planck constant of action. The process according to these equations is very simple. Each quantum gives up *all* its energy to a single electron (thereby distinguishing the photoelectric from the Compton and Raman effects later discovered) and if that energy is greater than $e\varphi$, the work necessary to get the electron through the surface, the electron is emitted.

In determining the maximum velocity of emission by direct experiment it is usual to apply an electron-retarding field between the illuminated metal and a surrounding receiver. If the potential difference between the metal and receiver is adjusted until the fastest photo-electrons are just prevented from reaching the receiver, this potential difference is called the stopping potential, V_s, and we have the relation

$$1/2\, mv^2_{max} = (V_s + V_c)e$$

where V_c is the Volta contact potential difference between the observed metal and the receiver and $(V_s + V_c)$ is the actual potential difference between these two. Furthermore, energy considerations led Einstein to the relation

$$(V_c)_{12} = \varphi_1 - \varphi_2$$

that is, the contact potential difference between two metals is equal to the difference of their surface work functions, having proper regard to sign.

These four equations express all the results of classical and early quantum theory with respect to the photoelectric effect, and we must now briefly consider the results of experiment in relation to them. The first Einstein equation expresses a linear relation between the maximum energy of emitted electrons and the frequency of the light, and the slope of this line should be h. The most consistent determination of h by this method is that of Lukirsky and Prilezaev (1928), and the photoelectric method is one of the best available for the determination of h. The determination of h does not involve any specific characteristics of either the illuminated or receiving surface, but does of course require that these characteristics should remain fixed during any one determination. No matter how contaminated the surfaces are, if they remain constant, the correct value of h should result.

Early measurements of long wave limits for various metals were extremely discordant, and it only gradually came to be realized that the surface and volume conditions of the metal altered the limit and the related value of φ in a very marked way. Attempts to clean the surface produced such large changes that for a time a considerable group of experimenters held the

view that for a really clean metal surface there would be no photoelectric effect whatever. It is only in the last few years that it has been possible for different observers to get concordant results. That these observers, even with their extremely painstaking methods, are really dealing with perfectly clean gas-free surfaces is very difficult to prove. I am inclined to think, from indirect evidence, that in many cases they are, and to hope that the values of ν_0 (or φ) now being secured can later be correlated to other fundamental properties of the metals in a systematic way. However this may be, recent work shows a good agreement between the photoelectric and the thermionic work functions, if proper allowance is made for temperature variations, and the photoelectric and thermionic measurements are made on the same specimen. In a similar way, recent work confirms the predicted relation between V_c and φ, if again observations are made on the same specimen. Agreements between observations of V_c by the observer and the corresponding φs by another must be considered accidental unless the metals have in both cases been very carefully cleaned. But no matter how contaminated the surface, if V_c and $\varphi_1\varphi_2$ are measured under the same conditions, they are found to bear the theoretical relation to each other. The cleaning process, granted the metals are sufficiently free from metallic impurities, is largely concerned with the removal of gas from the surface and body of the metal, and for this only two methods have been successfully used, distillation and extreme heating in the highest possible vacuum. During the process of removing the gas, the long wave limit for a given metal may shift by as much as 1,000 Å. In some cases the shift is at first in one direction and then in the other, but such complicated effects are probably due not alone to the removal of gas but to other changes brought about simultaneously by the heat treatment. In the end (and this may be only after hundreds of hours of heating, or prolonged redistillation) surface conditions are reached which are almost completely stable as regards further treatment, and which change so slowly in the high vacua at room temperatures that accurate observations may be carried out upon them. It is such surfaces, if any, which may be said to be gas free.

The expression for the photoelectric current-density may be written

$$i_\nu = f(\nu)\, I \quad d\nu$$

where I_ν is the intensity of incident radiation of frequency ν, and $f(\nu)$ gives the dependence of photocurrent on frequency for unit incident intensity. Obviously $f(\nu)$ would be expected to depend on a number of factors, namely: the reflecting power of the surface for light; the index of absorption of the metal for light, as determining the penetration of the light into the metal; what is sometimes called the "quantum efficiency" or the probability that an available quantum will excite a photoelectron; the absorption coefficient for photoelectrons in the metal, and an internal reflection coefficient for such electrons at the metal surface. In spite of the complicated possibilities which these considerations suggest, it is found that for most metals $f(\nu)$ runs a simple course from zero at the long wave limit to continuously increasing values at higher frequencies. For the alkali and alkaline earth metals $f(\nu)$ usually shows a pronounced maximum which only appears, if the surface is specular, when observed at oblique incidence with the parallel ("dig-in") component of the electric vector (E). An effort has been made to separate these effects into two independent types of "selectivity," one the difference in the effectiveness of the perpendicular and parallel components of E, the other the occurrence of a maximum in the $f(\nu)$ curve. The situation is much more complicated than at first appeared; but, though the experimental evidence is in many cases conflicting, from the early work of Millikan and Souder and the recent work of Fleischer and Dember, Ives, and Suhrman and Theissing, it is possible to draw certain conclusions, which though not finally established seem most probable.

(1) The two selectivities, vectorial and spectral, are probably aspects of one phenomenon, the former being largely determined by the roughness of the surface. (2) Even with the alkali metals, the usual selectivity is absent when the metal surfaces are in what one might call their simplest condition if the observations are expressed as current per unit of *penetrating* light intensity. (3) The selectivity does not result merely from the adsorption of gas on such a simple surface, but as Ives suggested, from the development of an invisible surface structure, which may take weeks to appear. (4) The effect of this surface structure is not merely to alter the absorption characteristics for light, but also to change the intrinsic photoelectric properties. (5) These effects are much influenced by the thickness of the layer of alkaline metal which is being studied, but are relatively insensitive to gas contamination.

If we may hope to learn something about the nature of this surface structure and how it operates, then there is much more work to be done, involving dispersed illumination, simultaneous measurement of reflecting power and photoelectric characteristics, and X-ray study of the structure of the surface; though it may well be that the structure we are interested in is not deep enough to show by X-ray examination. There is needed either great elaboration of technique, or a considerable and clarifying innovation.

Recalling again the various factors which determine the normal run of f(v), one might hope to separate these, which affect the velocity distribution as well as the number of emitted electrons, by a study of metal films of varying thickness, but such studies as carried out by Compton and Ross, Goldschmidt and Dember, Lukirsky and Prilezaev and Ives, have led to rather discordant results. This is not surprising when one considers not only the difficulty of measuring the thickness of very thin films, but also the difficulty of producing films which differ in thickness but are in other respects alike. From work with thin films the "mean free path" of the photo-excited electrons in metals is estimated at from 1 to 5×10^{-6} mm, while the thickness of the "active layer" or depth from which measurable numbers of photoelectrons can escape is in some cases put at 1×10^{-5} mm and in others as greater than 1×10^{-4} mm. In the nature of the case it is very difficult to free such films, once formed, from gas, and this is undoubtedly another reason for the discordant results. On the whole, work with thin films has been more successful in raising new questions than in answering old ones.

As directly observed, f(v) is in terms of unit incident energy, and one would like to eliminate the effect of the optical properties of the metal in order to get nearer to the quantum efficiency or probability of excitation. With massive metals—*i.e.*, much thicker than the "active layer"—the outgassing develops a surface crystalline structure, and it is doubtful if the optical constants R and κ measured on polished surfaces are applicable to the multi-crystalline surface. Only a few attempts have been made to measure simultaneously the optical and the photoelectric properties. It is not surprising then that observations of f(v) are discordant, and that no correlation between the f(v) for various metals has been obtained.

There have been some experimental advances in recent years which, though somewhat qualitative in nature, are of decided interest. Of these consider first the influence of temperature, which might conceivably alter the long wave limit, the various factors determining f(v), and the velocity distribution of the photoelectrons. It is important also to analyze the results from the standpoint of the probable cause, and it is usual to limit the term "temperature effect" to such as are *not* due to a change in a gas layer, or a definite allotropic change in the metal, though it is frequently not easy to eliminate changing gas conditions. In all, about a dozen metals have been studied with sufficient care so that some conclusion can be drawn concerning temperature variation, though for only a few metals do the results at all approach completeness. Generally, though not in all cases, the long wave limit moves toward longer wave-lengths with increasing temperature. In general also f(v) changes —sometimes without any measurable change in the long wave limit. The most complete studies have been made of tantalum, gold, and silver by Messrs. Cardwell, Morris and Winch, and from their unpublished results I quote the most systematic example of temperature variation which has been found. If one plots the photo-current per unit incident light energy as a function of temperature for a series of discrete wave-lengths, then for all three of these metals one finds that for wave-lengths near the long wave limit there is a marked *increase* in current, while for those roughly 200 Å or more shorter than the long wave limit there is a less marked but definite *decrease* in current with rising temperature. Put in another way, the current-frequency curve f(v) for high temperatures (600 to 800° C.) crosses that for room temperatures, the "toe" of the high temperature curve being more pronounced and the long wave limit less sharp and definite. Part of this systematic variation is foreshadowed in some earlier work of Ives with potassium and other alkali metals. That these systematic variations are real and not artifacts due to spectral impurity and the extremely rapid variation of sensitivity with wave-length near the limit, seems much more probable if one considers that two different dispersing systems—one double and one single—were used in the above work. As for interpretation, the *increase* in emission near the long wave limit and the extension of the "toe" of the curve is exactly what would be expected from the standpoint of increased kinetic energy of the conduction electrons from which the photoelectrons probably originate, but the *decrease* in emission for shorter wave-lengths would remain unaccounted for. Probably more complicated considerations are necessary, but in any event it appears to be a rather significant experimental result.

The study of the effect of temperature has brought out the effect of change in structure. The most marked changes are observed with iron, in which the $\alpha \rightarrow \beta$ and more particularly the $\beta \rightarrow \gamma$ transformations greatly alter the photoelectric characteristics. Cobalt shows at 850° C. changes very like those accompanying the $\beta \rightarrow \gamma$ transformation in iron, but the situation is more complicated, for resistance measurements indicate no transformation point at 850° C. but do indicate one at 450° C. which, however, does not appear photoelectrically. X-ray observations so far as they have been carried out agree with the photoelectric results in indicating a change in crystal structure at 850° C. Evidently the photoelectric effect and conduction are differently "structure-sensi-

tive," to use Goetz's term. Goetz has shown that the long wave limit increases progressively from β(2,740 Å) to γ(2,820 Å) to liquid (2,925) tin, but found *no* temperature change in photoelectric properties not associated with a change in structure.

All the work we have just been discussing has been done with multi-crystalline specimens, the study of single crystals, much to be desired, having been delayed by experimental difficulties. High melting point single crystals are difficult to produce, while low melting point single crystals would be either melted or recrystallized by the usual outgassing treatment. Unless this matter is very carefully considered, mistakes are likely to be made, and in particular it seems quite probable that different crystal faces might appear to be the same simply because the underlying characteristics are entirely concealed by gas contamination. On the other hand, positive evidence of a difference in the photoelectric behavior of different faces of a zinc single crystal, such as obtained by Linder, would appear to mean something even though outgassing precautions were not very carefully attended to. We have some preliminary evidence of a dependence of the long wave limit upon the crystal face, also in the case of zinc. In this case for the first time the crystals were grown in a very high vacuum, but were subsequently exposed to air for a short time. This is all that is known about the behavior of single crystals.

There is a general similarity in the behavior of metals during the outgassing heat treatment, to which attention may be called. Beginning with a surface condition resulting from rolling, annealing and mechanical cleaning by fine emery, the effect of the first heating is to cause a very considerable increase in general sensitivity, perhaps a hundredfold, followed by a more gradual decrease. During these changes the long wave limit shifts correspondingly, that is, toward long wave-lengths while the sensitivity is increasing, and toward short waves while the sensitivity is decreasing, indicating that at least the major part of the sensitivity changes are due to shifts in the long wave limit. During this part of the process, large amounts of gas are given off by the specimen. With most metals the final stage is reached by a gradual decrease in sensitivity to a steady value, the long wave limit becoming fixed at the same time. With iron and molybdenum, on the other hand, the final stage is reached by a further *increase* in sensitivity to a stable value. If air is admitted to the tube at any stage, the characteristics of the surface are changed to pretty closely their initial values. After such exposure a repetition of the heat treatment will, in a much shorter time, bring back values of long wave limit, etc., which had before been attained; but as far as our experience goes, the final condition is reached without passing through the original series of intermediate states. In other words, the heat treatment has produced a permanent change which is *not* reversed by mere exposure to gas. Whether this change is nothing more than the growth of fairly large crystal grains which are quite obvious to the eye, or whether it has to do with the removal of vaporizable metal impurities, or of gas from the body of the metal (the initial volume content of gas not having been reproduced by the relatively short re-exposure to gas which has been used) can not now be said. Probably all three factors—structure change, volume gas change and removal of impurities—have something to do with it. Work with single crystals should help to clear this up, and if once clean crystal faces can be obtained, a study of the effect of exposure to different gases should be of particular interest from the standpoint of the nature of the gas layers which are formed.

During the past few years there has been a decided revival of interest and activity in the electron theory of metals. Started by Sommerfeld, it has been carried on by Houstoun, Eckart, Fowler, Nordheim, Wentzel, and as regards our particular problem most recently by Frölich. The new theory, by the adoption of the Pauli exclusion principle (which may be described as social legislation to prevent overcrowding of the electrons) removes *a priori* the great difficulty with the older forms of the electron theory—namely, the specific heat paradox. According to the new picture, the valence electrons of the metal atoms become free in the solid state, but classical equipartition is given up and instead the energy distribution is given by the Pauli-Fermi-Dirac statistics, according to which the average electron energy is practically independent of temperature except at very high temperatures of the order of 10,000° C. At the absolute zero there would be a perfectly definite maximum electron kinetic energy (w_i), while at ordinary temperatures this maximum becomes less sharp and there is an approximately Maxwellian distribution over a short range period beyond w_i. For a metal having one free electron per atom, this maximum zero point energy corresponds to 7 or 8 volts. In dealing with the emission of electrons, the metal is treated as a *potential box,* and since the electrons are now given relatively large kinetic energies, the potential wall, w_a, of the box must be correspondingly higher than in the old theory, so that the difference $w_a - w_i$ will agree with the experimentally determined surface work function, φ. From the standpoint of the electrons we have played on them a typical protection-

ist trick—wages have been increased, but prices have gone up correspondingly, so that at first sight it might appear that we were no better off than before. There are however certain advantages, aside from the fundamentally important one of avoiding the specific heat paradox. The existence of velocities beyond the zero point maximum, the distribution curve rising with increasing temperature, leads to the conclusion that the long wave limit would be absolutely sharp only at the absolute zero, and that the *effective* or observed limit would shift toward long wave-lengths and become less sharp at higher temperatures. As we have seen, this is just what we have observed for tantalum, gold and silver, and it would be exceedingly interesting if these changes could be definitely connected with the predictions of the new statistics. At present we can not say whether the observed effects can be attributed solely to the temperature change in the electron velocity distribution.

The theory proceeds to consider the electrons in the potential box from the standpoint of wave mechanics, the effective minimum wave length of the electrons being of the order of a few Ångstroms. One immediate result is the computation of a *transmission coefficient* for electrons striking the potential wall, which depends upon the electron velocity and the height and form of the wall—that is, whether the potential change is sharp or gradual, whether the wall is flat or has a parapet, etc. For a given wall, and given *total* (kinetic plus potential) energy of the electrons, the transmission coefficient for internal electrons is theoretically the same as that for electrons approaching the surface from the outside. This gives an interesting opportunity to see whether transmission coefficients measured for electrons incident externally can be usefully applied to photoelectric and thermionic observations. Unfortunately, the theoretical transmission coefficient should differ from zero or unity only for a very narrow range of internal kinetic energies about equal to the height of the potential wall, and the kinetic energy of the corresponding external electrons would be of the order of a fraction of a volt. The determination of reflecting power for such slow external electrons is very difficult and up to the present there are no measurements available. If experimental values of the transmission coefficient could be obtained, then it might be possible to draw conclusions as to the form of the potential wall in specific cases, and this would be a most interesting result.

Of particular interest in relation to the surface electrostatic forces are the recent results of Suhrman, Becker and Mueller and Lawrence and Linford on the effect of external electric fields upon photoelectric characteristics. Working with the alkali metals it has been shown that relatively moderate external electric fields shift the long wave limit by considerable amounts, the effective value of φ changing by as much as 0.2 volt. Not only this, but the entire $f(\nu)$ curve is shifted toward longer wave-lengths, without change of form. This is quite in harmony with the theoretical view-point, according to which the form and effective height of the potential wall can be changed by the superposition of a sufficient external field. Furthermore, while a change in the potential wall should in general change the form of the $f(\nu)$ curve, the computed magnitude of this change turns out to be too small to detect under the conditions of Lawrence and Linford's experiment.

The more detailed wave mechanical theory has arrived at two further conclusions which are very general and perhaps capable of experimental test. The first is Wentzel's deduction that $f(\nu)$, giving the photo-sensitivity for unit penetrating radiation as a function of frequency, should in *all cases* have a maximum, and the theoretically determined position of this maximum agrees fairly well with the position of the selective maxima for some of the alkali metals. At first thought this seems an extremely significant agreement, but there are two considerations which decidedly lessen our satisfaction. The first is the accumulation of evidence, which we have already discussed, which strongly supports the idea that the selective maxima of the alkali metals are *not* characteristic of the metals themselves but are due to little understood surface conditions, and the second is the fact that with several of the alkali metals the selective maxima are followed on the ultra-violet side by a rising sensitivity curve which is *not* predicted by theory. For other metals having their long wave limits farther in the ultra-violet, the theoretical selective maxima come at such short wave-lengths that it is not surprising that they have not yet been observed. It may be that the general predictions of the theory are correct, but that it is a mistake to attempt to correlate them with the commonly observed selective maxima of the alkali metals, and the most interesting test of this will be to push observations with the heavier metals farther into the ultra-violet to see if any evidence of the existence of a maximum sensitivity can be obtained.

More successful is the correlation of the theoretical velocity distribution of photoelectrons with the observations of Lukirsky and Prilezaev on thin films of silver. With decreasing film thickness the observed velocity distribution curve becomes qualitatively quite similar to the theoretical curve, showing a preponderant number of electrons having nearly the maximum velocity. Since the theory has been worked out

only for a thin layer, neglecting the absorption of light and electrons in the metal, this agreement appears significant.

As Wentzel is careful to say, the theory so far is so idealized that one must be cautious in attempting to correlate it with experiment. In simplifying the problem from the theoretical standpoint, several factors have been neglected which are just those which the experimenter can not, or at least has not, eliminated. Most important of these is the structure of the surface, which has theoretically been assumed to be *perfectly smooth*. It is doubtful whether experiment can ever deal with a surface approximating this condition. Furthermore, until values of the internal absorption coefficient for both light and electrons are available, either from experiment or from more fundamental theory, the present type of wave mechanical theory will be limited in its application to *thin films*. As we have seen, experimental work with thin films has its own peculiar difficulties, and the results in many cases show new complications rather than the simplifications which one would hope for in order to compare with theory.

The present situation then is that while experiment is providing continually more complicated results, though to be sure they are undoubtedly more reliable and more reproducible, theory naturally asks for simple characteristics obtained under idealized conditions. Perhaps with better controlled experiments and more elaborated theory, we can reach not only an understanding of the fundamental photoelectric process, but also, what is of equal interest and importance, a better picture of the structure of a metal surface and of the gas layers which form on it.

PSYCHOLOGY'S FAMILY RELATIONS AMONG THE SCIENCES[1]

By Professor MADISON BENTLEY

CORNELL UNIVERSITY, CHAIRMAN, DIVISION OF ANTHROPOLOGY AND PSYCHOLOGY, NATIONAL RESEARCH COUNCIL

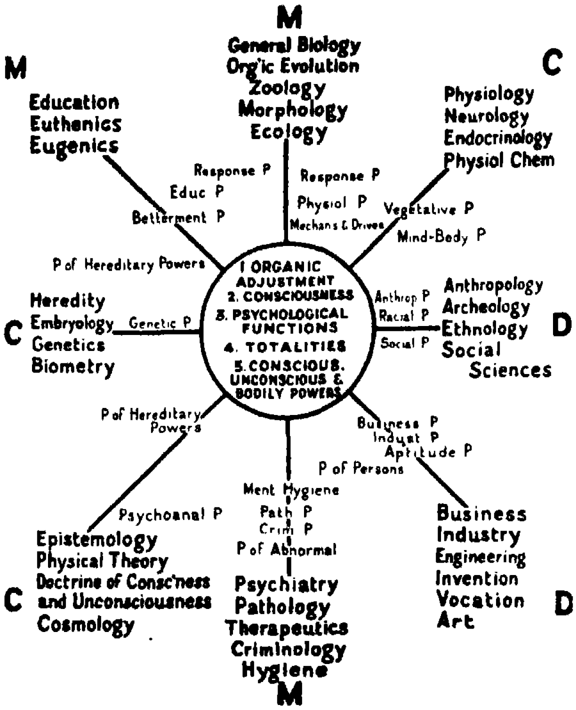
SCIENCES, like families, have their lines of descent. In some the ancestral strains are easily to be traced; in others the derivation is clouded by uncertainty or complicated by strange infusions. Some of the older sciences derive with great directness and simplicity from remote cosmogonies and philosophies; but the younger members often branch widely in process of generation, going back to disparate sources and interlacing with many other lines. For the contrast you have only to compare chemistry and biochemistry, physics and endocrinology.

Like the average family, again, the science possesses a large number of collateral relations. It has its brethren in other sciences, its cousins and nephews among the professions, and numerous legal kin acquired by solemn union with the arts and vocations. No occasion in the year so inevitably brings out these collateral relations as does the great winter pilgrimage of our tribes of the Triple-A to the common Mecca of the Faithful. Here we find many evidences of our familial ties and of our close fraternal dependencies; our intersectional interests, our passionate allegiance to the virginal mother, our implicit trust in the beneficent guidance of the Council of the Elders, our frigid intersectional shuttling from door to door in wintry blasts, our hybrid conferences, and our embracing symposia.

But the individual subject may itself be aptly used to exemplify the same sort of horizontal membering. Take psychology. It is not easy to enclose within a single central area all that is named by that name. And when we look beyond the more immediate boundaries, we observe a large number of widely radiating lines leading first toward a number of psychological specialties and ultimately to other collateral subjects each with its own family seat but each maintaining an intimate relation with psychology. These lines run outward from our own central domain toward general biology, zoology and ecology; toward physiology, neurology and endocrinology; toward anthropology, ethnology and sociology; toward business, vocation and industry; toward medicine, criminology and hygiene; toward physical and cosmological theories and doctrines of mind and matter; toward heredity, embryology and genetics; and, finally (if the long list may be completed), to education and human betterment. Add a multitude of cross-threads running helter-skelter throughout the figure and you have a gross representation of the great psychological family as it greets the New Year of 1931.

Now it is necessary that the inner circle of psychology be drawn wide enough to make room upon its convexity for all these centrifugal connections. But it is obvious upon inspection that the wide diameter has not been arbitrarily chosen. It has of necessity to embrace the existing schools and basal varieties.

[1] Address of the retiring vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, Cleveland, January 2, 1931.



These latter are many because of the wide range of outside interests, and the outside interests are multiform because psychologists variously envisage and variously develop their own subject. These two geometrical aspects are, then, wholly correlative, and they are derived from one and the same historical setting. For three decades at least psychologists have been reaching out to touch knowledge, the arts, the professions, and the affairs of every-day living. And at the same time all these human interests have been pressing in upon psychology, implicitly confessing that man's learning and man's living require facts and principles not otherwise supplied in the curriculum of the sciences.

Let it be observed that, in spite of this entanglement in the collateral lines, our outside connections, while many, are not wholly disordered. We count our brethren among the biologists, the neurologists and the students of early man; our cousins among the biometrists, therapeutists and promoters of hygiene; and our more distant relatives-by-adoption among such diverse strains of kinship as the historians of the law and of custom, the acoustical and optical engineers, personnel researchers and physicists speculating upon the nature of the cosmos.

Again, these connections imply certain distinctive attitudes assumed by our brethren toward their younger, psychological sibling. The first of these attitudes is one of active solicitude and suggestion. It has been conspicuous in three quarters, general biology, education and medicine. All three brethren have shown a willingness to conduct and to care for the affairs of psychology. Let us call these the *managing* relatives (M). So deeply have they set their mark that many observers have, in passing by, regarded psychology as a mere branch of biology, a mere convenience of education, or a mere application of medicine to mind. Three other consociated groups are *contributing* relatives (C). Present psychology would not be possible without the contributions generously made to it by physiology, bodily history and reflective theory. Every one who deals broadly with the living organism must know the body's functional devices and the body's mode of derivation and development. For general theory and speculative assumptions the empirical sciences have less use, and psychology can well afford to reduce still further her family intimacies in that direction; but as matters stand to-day that source of contributions can not be ignored. The chief *dependent* relatives (D) are two: the one the group of social studies and the other the practical and technical group at the southeast corner of the figure; the one depending upon psychology for a depiction of the socialized organism at work and the other for methods and means of estimating and measuring human differences in production and accomplishment.

Neither are we wanting in those more intimate and irregular relations which sometimes threaten to disrupt the smooth convexity of the family circle. The union of psychology and anthropology was formally recognized in our companionate Section H, but later dissolved by a decree of our discrete Council of Elders, restoring to both parties their singular freedoms. The case was not complicated by offspring; but fruitful relations have since been resumed between anthropology and psychology, and a whole chain of A and P trading-posts has now sprung up, the most conspicuous among them all to be found in our Division of the National Research Council. The fact that one individual—be he A or P—is now annually selected to nourish this bilingual offspring would seem to provide a practical sanction for such informal conditions of hybrid union.

We have also our frank illegitimacies, as certain irreconcilable behaviorists once disclosed. Apparently bred from biology, but eager to claim another birthright and bold to adopt another family name, the behavioristic pretender threatened to crowd all other fledglings from the nest. Fortunately the nest was widened by the aggressive intruder and his behavior has been gradually improved by more disciplined mates. The reformation is now cited to establish the conquest of hereditary taint and to prove that, no

matter how bad the egg, a good environment may suffice to make a decent bird.

Among those orphaned offspring of strange alliances which have been adopted by psychology stand that issue of metaphysics and medicine which still answers at times to the name of Freud and that other issue of epistemology and sociology which came to us under the alias of *Phänomenologie* and now proposes to prefix the Christian name "Social" to our family title.

The inseminating powers of the word in creating new members of a family group are well illustrated by anthroponomy and functionalism, and by a whole group of qualifiers which includes hormic, dynamic, reflexological, individual and biosocial.

Had ever a sober discipline so many relatives and so thorny a family tree? Or is psychology not sober? And does "discipline" less name her than name her needs? Have loose company and tight companions given her landscape an apparent rotatory blur? Is it all a temporary amblyopia? Or is her difficulty fixed in the genes and so predestined to disfigure her progeny?

Soon psychology must seriously consider the f_1 generation. With so many present alliances, exogamous and incestuous, and so many legal and irregular adoptions into family intimacy, provision against the future will presently become urgent. Naming the offspring will itself prove to be a task. There will be the little son who experts for the automobile-assembling crew, and others who control the efficient pasting of bottle labels and the making of soups. Wall-Street psychologists are coming on in litters, and so are the precocious advertising prophets, psycho-physicians to domestic disharmony, experts attached to football coaches, vocational horoscopists in nursery schools, and many other specialists. Each little psychologist must have his proper Christian name lest he develop an inferiority during his impressionable years.

But all that anxiety about the new brood may be left to the future. Sufficient unto the day. . . . Nor should we be disturbed by a recent rumor, imported from abroad, that psychology is a "curse." Our multiplicity of kinds and of tasks may have suggested to the uninformed that we are muddled or futile; but only a comedian designing a travesty or a zealot kindled by emotion would travel overseas to persuade the intelligent that psychology possesses the blighting power of the witch. Possibly we shall find that the query has mistaken psychology for some temporary cult current in another land or that it is only a jest turned to account for the pockets of clever debaters.

Our immediate concern is for

> The worried old lady, at sea in the blue,
> Who has so many collaterals
> She doesn't know what to do.

Some of our stricter monogamists offer simple remedies. "Connect sense organ and muscle," says one, "and christen them the Reflex Couple." "Body and mind," declares a second, "were eternally conjoined. Let no pagan put them asunder." "On the contrary," counsels a third, "divorce them, annihilate mind, and set a strict watch upon the future behavior of the liberated body." "If you will but give Psyche new glands," cries the plastic surgeon, "a new libido will appear and will instinctively select a proper mate." "Bring her to church with anthropology, with ethnology, education, sociology, medicine, hygiene," shouts the crowd of self-appointed advisers, "and have her respectably and usefully conjugated."

Now it is an astonishing fact that all this gratuitous advice has actually been offered and, in certain quarters, actually accepted. You have only to examine the writings of the psychological family during the past year to discover that each of these ligations has somewhere been assumed and turned to account. The result is striking. A large part of the literary product of the year and of other recent years lies in the great intermediate region bordering upon the periphery of our figure. So much, in fact, is in the periphery that it sometimes appears that psychology is chiefly a medley of interests and relations, without independent status, extending freely from biology on the one side to medicine on the other, from neurology to neurotics, from heredity to eugenics, and from instincts to social institutions, with only a colored vacuum to mark the central nexus of cross-reference. If we are not such a medley, it may be worth our while to encourage the accumulation of substance in the colored vacuum and thereby to consolidate our central field. It may well be doubted whether a subject which cultivates the title of science can long continue to do more than journeyman's jobs outside unless it has its own common principles and its distinctive subject-matter.

Possibly we should improve our perspective by asking as many of the relatives of psychology as bear the name of science to give us their views of our own subject. Relatives are notoriously frank and plain of speech. If we did, however, we should not find it easy to ignore the non-scientific members of the family group; education, medical arts, eugenics, human betterment, social and industrial practice, and the vocations. The heavy dependence of psychology upon these is readily to be seen when they are removed from the field. Psychology as it is now professed would certainly change its perspective without

their support. But the appropriate inquiry of the hour more specifically concerns the sciences. To these we must briefly turn.

At once we discover that the reference inward toward psychology from any one of the outlying sciences is generally toward some one particular variety, and not to the subject at large. Thus the group at the top, the biological group, stands related to that form or variety of psychology indicated by organic adjustment. For this there are two reasons. The first is that the fundamental doctrine of adjustment falls under biological theory. The second is that the emphasis here placed upon animal behavior is an ecological offshoot of zoology. It is chiefly among psychologists of this temper that the management and exploitation of their field by the biologists has been condoned. In a similar way, the lower center (conscious, unconscious and bodily powers) has been primarily directed and exploited by the medical cousins, uncles and aunts, with an added doctrinal importation from the speculative group in the extreme southwest. It is obvious, moreover, that the psychologists of consciousness and totality have also received large gifts from doctrinal and theoretical sources. At the same time, both these latter psychologies tend now to be more and more independent of these elder relatives and therefore more and more genuinely psychological.

It is interesting to observe that the hereditary group at the left has contributed to every central phase of psychology. Organic adjustment draws thence a genetic account in its own biological terms; consciousness sees itself individually developing upon a native organic base; the psychological functions imply stock as an enduring factor operative throughout life; totalities refer backward to primitive structures of figure-and-ground demanding bodily heritage and development; and the forces put to psychoanalytic uses imply both a bodily heritage and either an organic or a mental unfoldment. In a word, no general psychology has yet succeeded in our times without laying a basis in heredity and organic development.

On the side of the dependent relatives, it is clear that the backward reference toward psychology has usually been made toward a single central type. Thus the business group has usually drawn upon the doctrine of organic adjustment; though its methods have commonly come through the minor eccentric groups of educational psychology and the psychology of hereditary powers, thus deriving ultimately from tests and the statistical schools of biometry and genetics. Its debt is primarily to education and the biological sciences, however much it has received gifts at second-hand through these intermediating tradesmen. It has been only slightly tinctured by the central principles, facts and methods of psychology.

The anthropological and social dependence is more varied and more ambiguous. That large group comes groping to psychology not quite knowing what it wants in that direction and still less clear as to what it can get. Both uncertainties may very well indicate that the psychologies of the present are not prepared to serve the social studies. Sociology has had to be satisfied with its half-breed cousin christened social psychology and by an adoption of psychology's borrowed phrases about heredity and environment, instincts and dispositions, group-behavior and implicit responses. Cultural anthropology draws more variously, seeking with greater precision for psychological factors and causes to clarify the origin and the significance of its cultural products, *i.e.*, language, custom, ceremonial, manufacture, and the rest. Here is a legitimate want which psychology might well seek to satisfy by first acquiring a more empirical view of human socialization and then testing its view by an examination of those processes and resources by which man has produced the cultural objects. Until now she has created no body of fact and doctrine which is adequate to the great demands of cultural anthropology. Physical anthropology is still untouched by its psychological relations, and the anthropologist of human beginnings has been too closely engaged with the geologist and the comparative anatomist to trouble himself with psychological vagaries suggested by the naked fragments which he has turned up in cave and gravel wash. Finally, the anthropologists of the Galtonian type have, in their inquiries into human faculty, contented themselves with methods more biometric and educational than psychological, though sometimes couched in terms of the psychological functions.

The special and partial psychologies which lie scattered about the face of our figure are curious members of our large family. They must be counted with the f_1 progeny, for they derive, each and all, from a cross between the central member and a non-psychological parent. Do you not agree that they all stand, in point of resemblance, nearer the peripheral sire; educational psychology nearer education, social nearer the social sciences, psychoanalytic nearer medicine and metaphysics, vegetative nearer neurology, physiological nearer physiology, and the various psychologies of personality nearer the gross arts of every-day living? The prepotency of the non-psychological parent seems to me to be evident in their manner of operation and in their results, a fact which may be used to suggest a very important commentary upon the existing state of psychology, which has acquired

the knack of reflecting, as it moves, the variegated coloring of its surroundings. Psychology comes near to being all things to all environing sciences and to all human arts. Its services are too much those of a jack-of-all-trades, who has many facilities but no profession.

That is our state; but fortunately it is not our tendency. Our subject lacks central cohesion and organization. Its representative schools are too many and too various. They have had of late but meager means of exchange and few common interests and goals. That is the inevitable result of the last quarter of a century in the study of life and society and in business and industry. But I think that the state is changing. Signs of integration are not wanting. No one of our five centers in the figure is so impervious and so self-contained as it was ten years ago. Their dialects are acquiring more and more common terms and phrases. There is more tolerance and more give-and-take. More researches pass current in all centers. It appears that the processes of fusion and consolidation are waxing, and that, on the other side, psychology is tending away from the encompassing disciplines and interests. The time may therefore come when it will not be chiefly a minor branch of biology, a medical clinic for the disordered and the introverted, a testing room for education and the juvenile court, a meeting place for neurological vagaries, a cataloguer of social epithets, a diviner of vocations, and a fad of the curious. Diversity of tasks and multiplicity of interests are impressive signs of life and energy; but they do not take the place of central principles, common hypotheses and attested methods of research, all indications of sanity which can not safely be replaced by a common name, registration in a common directory, and adherence to a common section in the associated sciences. As psychology values more and more its independence, husbands more and more its unique resources, and clarifies more and more its proper relations among the sciences, it will, as I believe, deal more frankly and competently with certain functions and performances of the living organism which at present fall to the lot of no distinctive member of the whole large family of the sciences.

OBITUARY

MEMORIALS

THE late Dr. Bashford Dean, founder of the Department of Fishes in the American Museum of Natural History, and at the time of his death in December, 1928, honorary curator of ichthyology, left behind him a number of sets of magnificent unpublished drawings illustrating the embryology of three of the lowest fishes. His materials and drawings are being worked up by certain of his associates and former students, and the resulting papers will be published by the museum in parts as finished as "The Bashford Dean Memorial Volume—Archaic Fishes" in quarto size under the editorship of Dr. Eugene W. Gudger, bibliographer and associate in ichthyology. The first article, a "Memorial Sketch" by Dr. William K. Gregory, a former student of Dr. Dean and his successor as curator of ichthyology, was published on December 15. It consists of a twenty-two page sketch of Dr. Dean's life and work, divided into sections to show on what subjects he was working at various times. This is illustrated by a photograph and five half-tone portraits. Next there is a complete bibliography of Dr. Dean's writings comprising 315 titles. At the end are appendices containing lists of other memorial sketches, copies of resolutions and memorial minutes adopted by various organizations, and reports of the opening of memorial and research rooms and exhibits dedicated to Dr. Dean in both the Metropolitan Museum of Art and the American Museum of Natural History. This is illustrated by photographs of the memorial tablets in the two museums and by two other figures. This Article I of the Memorial Volume comprises forty-two pages, and has eight plates and two text-figures.

IN memory of Dr. William Diller Matthew, professor of paleontology, who died at the University of California on September 24, members of the faculty have arranged to give a series of seminars or discussions on paleogeography this spring, starting on January 21.

The first seminar will be led by Dr. Charles L. Camp, curator of reptiles and amphibians, who will review Dr. Matthew's book, "Climate and Evolution." Other men who will lead seminars are: R. W. Chaney, curator of paleobotany; Dr. B. L. Clark, professor of paleontology; Assistant Professor N. E. Hinds and Professor G. D. Louderback, of the geology department; Professor C. O. Sauer and Assistant Professor J. B. Leighly, of the geography department; Professor W. A. Setchell, Professor W. L. Jepson and H. L. Mason, of the botany department; Dr. H. M. Hall, of the Carnegie Institution, Washington, D. C.; Dr. Alden Miller, zoology department; Professor E. C. Van Dyke, entomology department; Professor T. Wayland Vaughan, director of the Scripps Institution of Oceanography, and Dr. C. E. Weaver, of the University of Oregon.

RECENT DEATHS

DR. RICHARD BISHOP MOORE, dean of the College of Chemistry of Purdue University, and an authority on the use of radium in treating disease, died on January 20. Dr. Moore was fifty-nine years old.

ELMER HOWARD LOOMIS, professor emeritus of physics at Princeton University, died on January 22, at the age of sixty-nine years.

DR. OREN HOWARD COBB, for the last eighteen years superintendent of the Syracuse State School for Mental Defectives, died on January 24. He was fifty years old.

MR. JOHN CLACEY, for many years optician at the National Bureau of Standards, died on January 12 at Washington, D. C. Mr. Clacey was one of the last of the old school of opticians, and before joining the staff of the bureau made many of the fine lenses in use in observatories of this country and abroad. Among the historical instruments made by Mr. Clacey is Chandler's almucantar with which the discovery of the variation of latitude was made. A brief account of his career appeared in *Popular Astronomy* for October, 1930.

Nature reports the following deaths: A. A. T. Brachet, For.Mem.R.S., rector of the University of Brussels, and director of the laboratory of embryology of the faculty of medicine in the university, aged sixty-one years; Major E. A. FitzGerald, author of "Climbs in the New Zealand Alps" and "The Highest Andes," on January 2, aged fifty-nine years; Professor Hans Kniep, director of the Institute of Plant Physiology at Berlin-Dahlem, on November 17, aged forty-nine years; Mr. H. A. Lowe, honorary fellow of the Textile Institute, who discovered in 1899 the process of "tensioning" mercerized cotton fiber on December 26, and Professor T. Wibberley, formerly Harrington professor of agricultural research, University College, Cork, who was known for his work on the breeding and introduction of new varieties of oats and wheat, on December 22, aged fifty years.

SCIENTIFIC EVENTS

CALENDAR REFORM

THE London correspondent of the *Christian Science Monitor* reports that the Council of the League of Nations has decided to invite all nations to discuss simplification of the calendar by international conference on October 26 next.

The three undisputed defects of the present calendar are: Unequal months, changing of week-day names for monthly dates, drifting dates for Easter and other church festivals.

The method which has found most approval is the division of the year into 13 months of 28 days each (the odd day to be an additional public holiday).

Every month would then be like February, 1931, in which the four Sundays fall on 1, 8, 15, 22 and the month is one of four weeks. Every fourth year Leap-day instead of being on February 29 would be in summer on June 29. The year-day, that is, the odd day of the 13 months, would be on December 29, and Christmas Day and holidays would all be fixed for Mondays, thus giving the workers the benefit of long week-ends.

By absorbing the last 13 days of June and the first 15 days of July the 28-day month would gather up all twenty-ninth, thirtieth and thirty-first days. All church festivals would be fixed, Easter Sunday being always on April 15 and Whitsunday on June 8.

Every month would therefore have a permanent economic value. The day of the week would always indicate the monthly date, and *vice versa*. Pay days, markets and meetings would recur on the same monthly dates. Weekly wages and expenses would be harmonized with monthly rents and accounts. Accounts and drafts would never fall due on Sundays. Permanent monthly dates for recurring fixtures in all walks of life would be established. All periods for earning or spending would be either equal or exact multiples of each other. Every month-end would coincide with the week-end most conveniently for business, rents and general affairs. Great statistical advantages would be secured by the ability to truly measure current fluctuations in government, export and business affairs.

A report of the national committee of the United States gives a percentage of 98.3 in favor of the 13 month calendar. This figure is obtained from a questionnaire submitted to 480 organizations. A number of large concerns both in Britain and the United States use private simplified calendars of 13 periods and 4-week months of 28 days.

In Germany there is evidence of much interest in calendar reform and Professor Erich Przybyllok, the Königsberg astronomer, has declared that little can be achieved without a publicity campaign. He finds all the Protestant churches in favor of reform; Jewish orthodox circles are agreeable to any change acceptable to the majority; the Roman Catholic Church is apparently against all alteration. He is of opinion that once the public understands the great advantages to be gained the weight of feeling will bring about the change.

THE MARSHALL FIELD ARCHEOLOGICAL EXPEDITION

An expedition which will excavate ancient Maya sites and collect artifacts representing the highest of aboriginal American cultures, search an uninhabited and almost impenetrable forest region for hitherto uncovered Maya cities, and study the Indians of modern Maya tribes by living for a period among them, left Chicago on January 21 on behalf of Field Museum of Natural History. On January 23 the expedition sailed from New Orleans aboard the steamship *Coppename* for British Honduras and Guatemala, where operations are to be conducted, it was announced by Stephen C. Simms, director of the museum.

This is the third Marshall Field Archeological Expedition to British Honduras, and it is to be led by J. Eric Thompson, assistant curator in charge of Central and South American archeology at the museum. Mr. Thompson led two previous expeditions sponsored by Mr. Marshall Field, as well as other exploring parties in this territory, and has written several books on ancient and modern Maya culture. The present expedition has a wider scope of operations than those which preceded it.

After landing at Belize, the expedition will proceed by boat up the coast to the mouth of the New River, and thence inland on the river to the head of navigation. Thence by mule pack train and on foot for many miles the journey will continue to the ancient city of Kax Unuic (Maya name meaning "Man of the Woods") which is situated on the frontier between British Honduras and Guatemala. There, with a party of Maya diggers recruited from among the native inhabitants, certain ruins will be excavated which promise to yield a rich collection of Maya antiquities for the museum, probably dating back to a time approximately coincident with the beginning of the Christian era or earlier.

When this work has been completed, the expedition will transfer its activities to the southeast Peten district of Guatemala, where reconnaissance work will be carried on through an extremely dense tropical forest region, uninhabited for many years, in search of the sites of ancient Maya cities known to exist but hitherto never definitely located. Work here will be entirely on foot, as the trails are too poor to take mules. The assistance of natives living on the edge of the forest, who are believed to have knowledge of the approximate location of the ruins, will be solicited. It is hoped that a number of old monuments bearing dates in Maya hieroglyphics will be found on the surface in the locality of the buried ruins. The explorations in this territory are a part of the expedition's work which is made possible by funds contributed by the Carnegie Institution of Washington, D. C.

Finally the expedition will pitch camp in the highlands of Guatemala to conduct ethnological work among certain modern Maya tribes. By living among these people and observing their ways of life it is expected that much new information will be obtained, and that it will be possible to trace many of the present customs back to the culture of the early Mayas. The expedition will be in the field probably about six or seven months.

THE AZTEC RUINS NATIONAL MONUMENT

Prehistoric Indian ruins of the pueblo type have been added to the Aztec Ruins National Monument, New Mexico, by the recent proclamation of President Hoover adding over eight acres to the reservation. The total area of the monument is now approximately 26 acres.

Two tracts of land comprise the addition. One, embracing 1.8 acres, was owned by the American Museum of Natural History, and donated by it to the government. It was through the generosity of one of the museum trustees, Mr. Archer M. Huntington, that the original area of the monument, amounting to 4.6 acres, was presented to the United States for monument purposes.

Later, in 1928, the Museum of Natural History donated an additional area of 12.6 acres which was added to the monument. Long before the establishment of the monument, the American Museum had conducted extensive archeological explorations in the area under the direction of Dr. Earl H. Morris, who was instrumental in obtaining scientific recognition of the value of its prehistoric ruins.

The other tract of land, containing about seven acres, was purchased by the government through the cooperation of W. T. Grant, of New York City, who donated $750, or half the purchase price, to the National Park Service for this purpose. The remainder of the cost was borne by the government appropriation, which provides for the acquisition of private lands in connection with national parks, provided half the cost is contributed from private sources.

The main feature of the Aztec Ruins National Monument is a large E-shaped pueblo structure containing approximately 500 rooms. The first floor of this structure is standing and in 24 of the rooms original ceilings are intact. In many places the walls of second-story rooms are standing, and in some cases also parts of third-story rooms. The ceilings, where in place, are supported by large beams, cut and dressed with stone tools. They are exhibits of work done in the Stone Age, while the sandstone walls, reasonably

plumb and with dressed faces, take high rank as examples of prehistoric masonry.

A museum collection has been installed in six of the excavated rooms in the old building. The nucleus of the material in it is a loan from the American Museum of Natural History. In addition, several hundred specimens have been donated by local people.

THE NEW YORK STATE FOREST RESEARCH INSTITUTE

The New York State Forest Research Institute, as a division of the work of the New York State College of Forestry, was established by action of the board of trustees at a meeting held in December. The objective in the establishment of the institute is to give the work in forest research now carried on by the college in different sections of the state a definite entity and more effective direction.

Research in forestry in New York is authorized under the charter given the college by the legislature of the state. The board of trustees during the past eighteen years have, in carrying out the obligations of the charter, set up special divisions of the college, such as the State Ranger School at Wanakena, the Roosevelt Wild Life Forest Experiment Station and various other experiment stations.

The purpose of the trustees in establishing, at this time, the State Forest Research Institute is to so coordinate forest research as now carried on by and through the college that the results may be applied in a more practical way to the practice of forestry in the state, but particularly in private and public reforestation which is now being done on a large and aggressive scale.

The plan for the Research Institute was presented to the board of trustees by Dean Hugh P. Baker, of the college. The institute will bring into more effective direction and cooperation several college agencies now operating somewhat independently. The program of the institute will be worked out by and through the college faculty. Mr. Clifford H. Foster, director of the Pack Demonstration Forest near Warrensburg, New York, is to be acting director of the institute.

Forest research is now being done on the Ranger School Forest of 2,300 acres at Wanakena near Cranberry Lake in the western Adirondacks; at the Pack Demonstration Forest of 2,400 acres near Warrensburg, New York; at the State Forest Experiment Station in Syracuse; on the lands owned by the college near Salamanca in Cattaraugus County, and by other divisions of the college. All these activities will be coordinated and directed under a single head.

That the state-wide reforestation program now in progress under the direction of the Conservation Department might be definitely assisted by results secured from centralized forest research was indicated by Dean Baker in presenting the plan to the trustees. It is, therefore, important to have this particular phase of forestry in New York given a definite entity and centralized at the institution whose charter from the state obligates it to carry on such work. The centralization of this endeavor at the College of Forestry at Syracuse should result in more comprehensive forest research than formerly, particularly as this work is now being carried on under appropriations supplied by the state for forest investigations. In the aggregate a considerable sum of money is being devoted to forest research by the state, but on account of the unrelated direction of this work there has been some overlapping and duplication.

THE INTERNATIONAL CONGRESS ON ILLUMINATION

The International Congress on Illumination will be held in Great Britain from September 2 to September 19, inclusive. It will bring together scientific men and engineers from the leading countries of the world and will provide for the exchange of scientific data and other information relating to the more important phases of lighting practice. Austria, Belgium, Czechoslovakia, France, Germany, Great Britain, Holland, Hungary, Italy, Japan, Sweden, Switzerland and the United States are represented on the International Commission on Illumination.

The technical sessions of the congress will be held in several cities, thus interspersing travel with the study of lighting problems. Registration for the congress will take place in London on the first three days of September, during which time a reception will be held and visits made to places of technical interest, according to the Hon. Secretary of the Congress, Col. C. H. S. Evans, of the British Illuminating Engineering Society. The first session will be held on September 4 in Glasgow. Meetings and visits to points of interest will follow in Edinburgh on September 6, 7 and 8; Sheffield, September 9 and 10; Birmingham, September 11 and 12, while on September 13 a tour will be made from Birmingham to Cambridge. The various technical meetings and plenary session of the International Commission on Illumination will be held at Trinity College, Cambridge, from September 14 to 19, inclusive.

The dates have been chosen to enable the delegates to attend the three-day celebration in London of the Faraday Centennial, immediately following the congress. The centennial includes a meeting of the Institution of Electrical Engineers and will be followed in turn by the annual meeting of the British Association for the Advancement of Science.

The following topics have been designated places of

importance on the papers program and discussion periods to take place at Cambridge: Factory, Office and Home Lighting, Aviation, Lighthouses and Buoys, Street Lighting, Traffic and Motor Vehicle Lighting, Floodlighting, Architectural Lighting, Natural Lighting, Laboratory Technique, Mine Lighting, Museum Lighting and Lighting Bureaus.

The U. S. National Committee of the International Commission has been charged with the responsibility of management and direction for four important divisions of the commission's activities. These are: Motor Vehicle Lighting, Factory and School Lighting, Aviation Lighting and Applied Lighting Practice in fields not otherwise specifically assigned. The need for agreement on some essential features of aviation lighting has already resulted in preliminary meetings abroad under the auspices of the International Commission and the forthcoming meetings will undoubtedly bring together important specialists in this newer field of lighting.

The American contributions to the papers program are under the supervision of a committee composed of Mr. A. L. Powell, of the General Electric Lighting Institute, Harrison, New Jersey; Dr. C. H. Sharp, Electrical Testing Laboratories, New York; H. H. Magdsick, Nela Park Engineering Department, Cleveland; F. C. Hingsburg, Airways Division, Department of Commerce, Washington, D. C.; E. C. Crittenden, Bureau of Standards, Washington, D. C.; L. A. S. Wood, Westinghouse Electric and Manufacturing Company, Cleveland, and G. H. Stickney, General Electric Company, Nela Park, Cleveland.

Members of engineering societies and others interested in the science and art of illumination are eligible to attend the congress. Those interested are requested to register as soon as possible by application to the Assistant Secretary of the Illuminating Engineering Society, 29 West 39th Street, New York City.

The officers of the U. S. National Committee are: *President*, E. C. Crittenden; *Secretary-treasurer*, G. H. Stickney. The membership includes representatives of the following societies: American Institute of Electrical Engineers, Illuminating Engineering Society, National Electric Light Association, American Physical Society, Bureau of Standards and the Optical Society of America.

The attendance and transportation committee for the congress includes Dr. C. H. Sharp, chairman; J. W. Barker, dean of engineering, Columbia University, and S. E. Doane, consulting engineer, New York City.

SCIENTIFIC NOTES AND NEWS

DR. W. W. KEEN, emeritus professor of surgery at the Jefferson Medical College, Philadelphia, celebrated his ninety-fourth birthday on January 19.

MR. THOMAS EDISON will celebrate his eighty-fourth birthday on February 11. He left last week for Fort Myers, Florida, where he expects to continue his work on rubber from native plants.

THE Willard Gibbs Medal for 1931 has been awarded by the Chicago section of the American Chemical Society to Dr. Phoebus A. Levene of the Rockefeller Institute for Medical Research "as the outstanding American worker in the application of organic chemistry to biological problems." The citation eulogizes Dr. Levene for his studies in nucleic acid, amino sugars, lecithins, cephalins, fatty acids, cerebrosides, inorganic esters of sugars, thiosugars in yeasts, hydroxy acids, and amino acids, as well as for his work in stereochemistry. Dr. Levene will be the twentieth recipient of the medal at a formal ceremony to be held later in Chicago. Previous medalists have been Svante Arrhenius, of Sweden; Madame Curie, of France; Sir James C. Irvine, of Scotland, and the following Americans: T. W. Richards, L. H. Baekeland, Ira Remsen, Arthur A. Noyes, Willis R. Whitney, E. W. Morley, W. M. Burton, W. A. Noyes, F. G. Cottrell, J. Stieglitz, G. N. Lewis, M. Gomberg, J. J. Abel, W. D. Harkins, Claude S. Hudson and Irving Langmuir.

IT is announced that Sir Ernest Rutherford who was raised to a peerage in the British New Year's Honors List will henceforth be known as Lord Rutherford.

THE council of the Royal Astronomical Society has awarded its gold medal to Professor W. de Sitter, director of the Leiden Observatory, for his theoretical investigations on the orbits of the satellites of Jupiter, and his contributions to the theory of relativity. A Jackson-Gwilt Medal and Gift is awarded to Mr. Clyde W. Tombaugh, Lowell Observatory, Flagstaff, Arizona, in recognition of his discovery of Pluto.

DR. KURT RUMMEL, of Warmestelle, Dusseldorf, was presented with the Melchett Medal, awarded by the British Institute of Fuel, by the president, Sir David Milne Watson, at the Institute of Civil Engineers on January 23. The medal was instituted by the late Lord Melchett, founder-president of the Institute of Fuel.

DR. DAVID MARINE, assistant professor of pathol-

ogy at the College of Physicians and Surgeons of Columbia University since 1920, and director of laboratories at Montefiore Hospital, was presented with the gold medal of the New York Academy of Medicine on January 7, for his research into the structure, functions and diseases of the thyroid gland. Dr. Marine was unable to attend the ceremony on account of illness.

AT the Cleveland meeting, the American Society of Parasitologists elected its first group of foreign honorary members as follows: Emile Brumpt, France; Otto Fuhrmann, Switzerland; Akira Fujinami, Japan; Friedrich Fülleborn, Germany; G. H. F. Nuttall, England; Edoardo Perroncito, Italy, and Arnold Theiler, South Africa.

THE Chilean Nitrate of Soda Nitrogen Research Award of $5,000, administered by the American Society of Agronomy, was, at the recent meeting of the society in Washington, divided equally among Dr. J. J. Skinner, senior biochemist of the Bureau of Chemistry and Soils, U. S. Department of Agriculture; Professor L. G. Willis, soil chemist of the North Carolina Experiment Station, and Dr. James K. Wilson, professor of soil technology, Cornell University.

AN exhibit of reproductions from x-rays prepared by Clinical Professor Harold Brunn and Instructor Selling Brill, in the J. J. and Nettie Mack Thoracic Surgery Clinic of the University of California, has been awarded first prize by the Scientific Section of the Radiological Society of America.

MR. FRANCIS LEE STUART, consulting engineer, of New York City, was inducted as president of the American Society of Civil Engineers at the opening session of its annual meeting on January 14.

DR. VICTOR G. HEISER, of the Rockefeller Foundation, was elected president of the newly organized International Leprosy Association at the meeting in Manila of the Congress of Leprologists, which adjourned on January 22; the vice-presidents, Dr. Chagas, of Brazil, and Dr. E. Muir, of Calcutta; the secretary, Dr. R. G. Cochrane, of London, and the treasurer, Dr. Brown, of the Bureau of Science, Manila. The temporary editors of the new journal on leprosy will be Dr. H. Windsor Wade, of Culion, the Philippines, as editor, and Dr. Lee, of Norway, and Dr. Maxwell, of China, as his assistants.

MR. STANLEY FIELD was reelected president of Field Museum of Natural History for the twenty-third time at the annual meeting of the board of trustees of the institution held on January 19. All the other officers who served during 1930 were also reelected for 1931. They are: Martin A. Ryerson, *first vice-president;* Albert A. Sprague, *second vice-president;* James Simpson, *third vice-president;* Stephen C. Simms, *director and secretary,* and Solomon A. Smith, *treasurer and assistant secretary.* The membership of the board now includes, in addition to these officers, the following: John Borden, William J. Chalmers, R. T. Crane, Jr., Marshall Field, Ernest R. Graham, Albert W. Harris, Samuel Insull, Jr., William V. Kelley, Cyrus H. McCormick, William H. Mitchell, Frederick H. Rawson, George A. Richardson, Fred W. Sargent, Silas H. Strawn and William Wrigley, Jr.

DR. MAZYCK P. RAVENEL, professor of preventive medicine and bacteriology at the University of Missouri, has been appointed consultant in public health and medical education to the Missouri State Board of Health.

DR. CALVIN H. KAUFFMAN, professor of botany and director of the University of Michigan Herbarium, retires with the title of professor emeritus of botany and director emeritus of the university herbarium, at the end of the academic year. He will be succeeded by Dr. Edwin B. Mains beginning with the second semester.

PROFESSOR WILLIAM M. GOLDSMITH has resigned his position as head of the department of biology of Southwestern College, Winfield, Kansas, to accept the position as professor of embryology and histology and lecturer in eugenics in the Municipal University of Wichita. Dr. Goldsmith was succeeded at Southwestern College by Dr. B. R. Coonfield.

DR. JOHN SHAW DUNN, professor of pathology in the University of Manchester, has been appointed to the chair of pathology in the University of Glasgow.

DR. WALDEMAR KAEMPFFERT, after having spent two and a half years in organizing the Museum of Science and Industry at Chicago, has handed in his resignation as director, to take effect on March 1. Mr. Kaempffert will become a member of the editorial council of the New York *Times* and will direct that paper's policy so far as science, engineering and industry are concerned. The work of designing and collecting exhibits for the museum will go forward uninterruptedly in accordance with the program originally formulated by Mr. Kaempffert and approved by the board of trustees. No successor has as yet been considered.

DR. D. S. VILLARS, assistant professor in physical chemistry at the University of Minnesota during the school year 1929–30, who later spent five months working in the research laboratory of the General Electric Company in Schenectady, has been appointed physical chemist in the research laboratory of the

Standard Oil Company of Indiana at Whiting, Indiana.

DR. MAJOR G. SEELIG, professor of clinical surgery in the Washington University School of Medicine, who retired from active practice last June, assumed the directorship on January 1 of a program of cancer research to be initiated at Barnard Free Skin and Cancer Hospital.

DR. C. C. YOUNG, director of laboratories of the Michigan Department of Health, has been appointed head of the department of preventive medicine at the Detroit College of Medicine and Surgery. He will continue in the same capacity in Lansing, having supervision of the work in Detroit.

DR. M. C. HALL, chief of the zoological division, Bureau of Animal Industry, has been designated president of the Permanent International Committee on Parasitology of the International Zoological Congress. This congress, which held its convention in Padua, Italy, in 1930, meets every four years to discuss subjects of international scope in the study of animal life. The committee is primarily concerned with the nomenclature of parasites.

MM. ROUX, Painlevé, Bouvier, Urban, Perrin, Grignard and Weiss and the permanent secretary have been appointed by the Paris Academy of Sciences members of the executive committee of the "Fondation nationale pour la découverte scientifique."

DR. A. J. GROUT will be at the Biological Laboratory at Cold Spring Harbor, Long Island, for six weeks each summer (in 1931, from July 31 to September 10) to take charge of such students and investigators as may wish to take up any problems connected with bryophytes: ecology, morphology, physiology or taxonomy.

DRS. DAVID H. KLING and Louis Nathan have been awarded fellowships of $2,400 each for 1931 by the committee of the Brown Orthopedic Research Fellowship of the Hospital for Joint Diseases; Dr. Kling won a scholarship last year. He will continue his researches on the fluids of joints; Dr. Nathan's research will deal with osteomyelitis and infantile paralysis.

DR. DAVID M. DENNISON, associate professor of physics at the University of Michigan, has leave of absence for the second half of the academic year to enable him to complete his work on the "Infra-red Band Spectra," undertaken at the request of the American Physical Society for publication in its quarterly journal, *Review of Modern Physics*.

DR. ROBERT P. MARSH, professor of biology at Gettysburg College, has been granted a sabbatical leave for the second college semester to be spent in travel and study in Europe. He will sail on January 30 for Italy and will return from Scotland in the fall.

DR. WOLFGANG PAULI, of the Technische Hochschule at Zurich, and Dr. Arnold Sommerfeld, of the University of Munich, were appointed to special lectureships in theoretical physics for the summer session of 1931 at the University of Michigan.

DR. ALBERT LA FLEUR, head of the department of science at Ball State Teachers College, Muncie, Indiana, has been invited to act as director of geography for a field trip organized by the department of geography in the University of Nebraska. The trip, which will start on July 18, is to continue for seven weeks. The itinerary includes Memphis, Chattanooga, Nashville, Washington, D. C., Boston, Baltimore, Philadelphia, New York, Quebec, Montreal, Toronto, Niagara, Detroit, Chicago, then back to Lincoln, Nebraska, the starting point. A region of special interest for study will be the lower St. Lawrence. The trip will include more than six thousand miles.

DR. C. H. MYERS, professor of plant breeding at Cornell University, left Ithaca on January 24 for China where he will serve as expert in the cooperative crop improvement project now in its fifth year. Other experts from Cornell University who have cooperated in this project are Professors H. H. Love and R. G. Wiggans.

ON January 8 and 9, Dr. E. M. East, professor of genetics at the Bussey Institution, Harvard University, lectured at the University of Michigan under the auspices of the Department of Zoology on "Heredity and Human Problems," "Possible Immunological Reactions in Plants" and "The Self-Sterility Problem."

PROFESSOR JAMES G. NEEDHAM, of Cornell University, lectured at the University of Michigan under the auspices of the Department of Zoology on January 19 and 20. A lecture on "War a Biological Phenomenon" was presented before a general audience. Two lectures of a technical nature, "May Flies" and "Transformations in Insects," were subsequently given.

DR. ROBERT H. GAULT, professor of psychology at Northwestern University, lectured at the University of Iowa on January 16 under the auspices of the Baconian Lecture Series on "Hearing through the Sense of Touch."

DR. OLIVER D. KELLOGG, of the department of mathematics of Harvard University, will open a course of lectures on February 9 as exchange professor at Knox College. Professor Proctor F. Sherwin, of the English department, will lecture at Harvard.

SIR WILLIAM B. HARDY, director of the Low Temperature Research Station of Biochemistry at the University of Cambridge, who will deliver the Abraham Flexner Lectures for 1931 in the Vanderbilt University School of Medicine, will arrive in Nashville to begin his work on February 15. Sir William will remain in residence at the School of Medicine for a period of two months, during which time he will lecture to the students and faculty of the School of Medicine, and will possibly deliver some public lectures. The Abraham Flexner Lectureship was established in the Vanderbilt University School of Medicine in 1927 by Dr. Bernard Flexner, of New York City. The lectureship brings in alternate years a scientific man of international reputation to the School of Medicine. Dr. Henrich Pohl, director of the Anatomical Institute of Hamburg, delivered the first lectures during the spring of 1928.

THE Galton Lecture, entitled "Warnings from Nature," will be given by Sir J. Arthur Thomson before the Eugenics Society, London, at the Galton Anniversary Dinner on February 16.

THE Hunterian Lecture was delivered before the Hunterian Society of London on January 19, by Dr. Arnold Lorand, of Carlsbad, on "The Problem of Rejuvenation."

THERE will be held in Rome, from June 3 to 7, an International Scientific Congress on Population in connection with the Second General Assembly of the International Union for the Scientific Investigation of Population Problems, this congress to be open to scientific papers by non-members as well as by members of the International Population Union. The congress will be divided into the following sections, for the reading of scientific papers, subject to possible changes as the plans develop: biology, demography, economics, anthropology, sociology, history, methodology.

THE eleventh summer session of the American School of Prehistoric Research will open in London on Wednesday, July 1, 1931, and close on the continent about September 8. The program includes lectures by the director and by foreign specialists, study of museum collections, excursions to important prehistoric monuments and sites, and actual experience in digging. Countries to be visited include southern England, France, Switzerland, Germany and Czechoslovakia. Students will have digging practice in a Paleolithic rock shelter (Dordogne) France. The last four weeks of the term will be devoted to digging in Neolithic and Metal-Age sites of Czechoslovakia; this part of the program will be in charge of Dr. V. J. Fewkes, of the University Museum, Philadelphia, assisted by Robert W. Ehrich, of Harvard University. Preference will be given to applicants who have a knowledge of French and German and who already have a bachelor's degree. Those who wish to enroll should apply immediately. Applications and requests for further information should be addressed to Dr. George Grant MacCurdy, Director, American School of Prehistoric Research, Peabody Museum, New Haven, Connecticut.

THE Eighth Congress of the Far Eastern Association of Tropical Medicine opened at Bangkok, Siam, on December 8. British India and the various provinces were represented by nine delegates, all Europeans. Japan, Formosa, Korea and Kwantung together sent seven; the Dutch East Indies five; the Straits Settlements, Federated Malay States, Hongkong and Indo-China three each; the Philippines two; other countries represented being Hawaii, British North Borneo and Macao. China was the only far eastern country not represented. The League of Nations was represented by Professor B. Nocht, and the Rockefeller Foundation by Dr. Victor G. Heiser. Some 177 medical men took part. The King of Siam sent a message of welcome and the congress was formally opened by the Minister of the Interior. The president elected for this congress was the King's physician (Prince Thavara), who in his address sketched the history of both old and modern medicine in this country.

DISCUSSION

THE VAMPIRE BAT

BLOOD-FEEDING bats in tropical America are mentioned by some of the earliest writers following the conquest of South America.[1] The exact species of these bats responsible for attacking man and other animals apparently remained unknown until Charles Darwin,[2] naturalist, on the memorable voyage of the *Beagle*, caught one in the act. He writes under the entry of April 9, 1832:

> The Vampire bat is often the cause of much trouble, by biting the horses on their withers. The injury is generally not so much owing to the loss of blood as to the inflammation which the pressure of the saddle afterwards produces. The whole circumstance has lately been doubted in England; I was therefore fortunate in being present when one (Desmodus d'orbignyi, Wat.) was actually caught on a horse's back. We were bivouacking late one evening near Coquimbo, in Chile, when my

[1] Flower and Lydekker, "Introduction to Study of Mammals, Living and Extinct," p. 676, 1891.

[2] "Journal of Researches into the Natural History and Geology of the Countries Visited during the Voyage of H.M.S. *Beagle* Round the World," p. 22, 1838.

servant, noticing that one of the horses was very restive, went to see what was the matter, and fancying he could distinguish something, suddenly put his hand on the beast's withers, and secured the vampire. In the morning the spot where the bite had been inflicted was easily distinguished from being slightly swollen and bloody. The third day afterward we rode the horse, without any ill effect.

Concerning the vampires, Flower and Lydekker write:

These Bats present, in the extraordinary differentiation of the manducatory and digestive apparatus, a departure from the type of other members of the family unparalleled in any of the other orders of Mammalia, standing apart from all other mammals as being fitted only for a diet of blood, and capable of sustaining life upon that alone. Travellers describe the wounds inflicted by the large sharp-edged incisors as similar to those caused by a razor when shaving: a portion of the skin being shaved off and a large number of severed capillary vessels thus exposed, from which a constant flow of blood is maintained. From this source the blood is drawn through the exceedingly narrow gullet—too narrow for anything solid to pass—into the intestine-like stomach whence it is probably gradually drawn off during the slow process of digestion, while the animal, sated with food, is hanging in a state of torpidity from the roof of a cave or the inner side of a hollow tree.

The sanguivorous nature of the vampires has thus long been known to mammalogists, but so far as I recall, these bats have never been referred to as among the parasites of man or other mammals. If many of the blood-sucking arthropods, such as the bedbug, are parasites, surely the vampires must be so classed.

The vampires range in distribution from Mexico, through Central America and throughout the warmer parts of South America. Several forms of them are known, being placed in three genera, *Desmodus Diphylla* and *Diaemus*, the last known only from Brazil and Guiana. Contrary to popular belief, these bats are of small size, the length of head and body being but about three inches. They are fairly common in many places and consequently must do considerable biting in order to exist.

No instance is recalled in which their attacks on human beings have resulted in more than trifling annoyances. Goldman[3] quotes Dr. Linnaeus Fussell, who had medical charge of a U. S. Government surveying party in eastern Panama in 1870 as follows:

The bites of vampire bats should be referred to, as the stories told of them are by many deemed rather apochryphal. We were troubled with them more or less during the whole time we were out, but ordinarily they did not prove a serious annoyance; toward the latter part of our trip, however, someone was bitten almost every night; one night, the 13th of May, nine men were bitten. The men were rarely awakened by the bites, which, however, bled freely, sufficient blood being usually lost to saturate the clothing and to show its effects very perceptibly in the loss of color and general feeling of weakness experienced.

The same manner of attack and the apparent lack of sensation in the act of biting is described by William Beebe.[4] He says of them:

For three nights they swept about us with hardly a whisper of wings, and accepted either toe, or elbow, or finger, or all three, and the cots and floor in the morning looked like an emergency hospital behind an active front. In spite of every attempt at keeping awake, we dropped off to sleep before the bats had begun, and did not waken until they left. We ascertained, however, that there was no truth in the belief that they hovered or kept fanning with their wings. Instead they settled on the person with an appreciable flop and then crawled to the desired spot.

Although the vampire bats must be regarded as among the free-living or temporary ectoparasites of man and other mammals, they can scarcely be regarded as more than curiosities in the field of human medicine. They are very much more easy to secure protection from than are mosquitoes and bedbugs. It has never been shown that they are carriers of any infection. In the field of animal husbandry they may at times be of more than passing interest.

MARCUS WARD LYON, JR.

SOUTH BEND, IND.

[3] "Mammals of Panama," Smith. Misc. Coll., Vol. 69, p. 209, 1920.

[4] "Edge of the Jungle," p. 18, 1921.

CONCERNING EARLY DIAGNOSIS OF WHOOPING COUGH

BEFORE diagnosis is attempted by the cough-plate method,[1] the beginner should master three important technical steps:

(1) The medium should be sterile, bright red and the surface should not be dry.

(2) A series of Petri dishes should be inoculated with B. pertussis and the small, discrete, round, elevated, shiny gray colonies should be studied from day to day. On the third to fifth day the colony approximates 1 mm in diameter and is surrounded by a zone which appears translucent in transmitted light and darkened in reflected light.

(3) Duplicate plates should then be exposed to early cases of known pertussis. Over-growth by mouth saprophytes can in part be avoided if the child drinks water just before the plates are exposed. An

[1] L. W. Sauer and L. Hambrecht, "Whooping Cough—Early Diagnosis by the Cough-Plate Method," *J. A. M. A.*, vol. 95, p. 263, July 26, 1930.

uncovered plate is held vertically, a few inches from the open mouth at the moment of expulsive coughs from the deeper bronchi. The plate should be incubated at 37° C. within a few hours, and be examined daily for four or five days. Rapidly growing saprophytes should be cut out with sterile platinum wire. The characteristic, zoned colonies usually appear on the third to fifth day. A hand lens used in bright light is helpful in finding the raised, circular colonies in thickly seeded plates. Poorly exposed plates should not be incubated. After mastery of the technic, aluminum boxes (4 cm × 1.5 cm) may be used. They require less medium, can conveniently be carried, and dry out more slowly (broad rubber band over seam).

Pertussis organisms are minute, oval, gram-negative bacilli which stain feebly. Polar staining may be present. If the cough has already persisted for several weeks, plates exposed to the other, susceptible children of the family will more likely be positive. A negative plate does not exclude pertussis, and a second plate may be positive. If the cough has persisted too long, or if it is not whooping cough, pertussis bacilli will not be found.

LOUIS W. SAUER
EVANSTON, ILLINOIS

THE FINDING OF LARGE CENTIPEDES IN WYOMING AND WESTERN NEBRASKA

ANY one acquainted with the Southwest is also more or less familiar with the wide-spread occurrence of centipedes, in sizes of two or three inches up to eight or more inches in length; and one of the items that has been considered an advantage to camping in the North is the absence of these pests. The writer has spent parts of every year for more than twenty-five years past in camp pretty well all over the region in question, and in contact with many others very familiar with such matters, and it has been a generally accepted belief that east of the Rockies in Colorado none of the centipedes of material size were ever to be found north of Colorado Springs and but very seldom north of Raton Pass along the New Mexico-Colorado border.

It was with astonishment, therefore, almost bordering on incredulity, that I heard Graham Bell Fairchild, student entomologist from Harvard University, casually mention killing about a four-inch centipede in camp about three miles south of Torrington, Wyoming, in the hills bordering the North Platte Valley, in the latter part of June, 1930. However, others were also killed here later this summer, and shortly after this members of the Country Club killed a four-inch centipede in the Country Club house at Scottsbluff, Nebraska, at a point about thirty miles east of the Torrington locality. These people thought it must have been a centipede brought in with fruit from the South in some fashion, but there would seem to be no chance of this being true at the Torrington locality. As local people who have lived all their lives in these sections and the surrounding region have never seen such centipedes before and as this is nearly five hundred miles north of the common range of such species the occurrence seems worthy of record. No attempt was made to identify the species, but the writer has requested that if others be found they be preserved in alcohol.[1]

HAROLD J. COOK
AGATE, NEBRASKA

THE EXCELSIOR GEYSER AGAIN

IN a letter from T. E. Hofer, Clinton, Washington, referring to my communication to SCIENCE, vol. lxviii, pages 644–645, I find the following testimonial to the vigor of Excelsior Geyser when it was active:

> Reading your Excelsior, Yellowstone Park notes, I was once crossing with a pack outfit about 200 yards below the geyser, when the darn thing exploded. We got all the animals safely across (on the geyser side), when the river rose about 10 inches, enough to have killed the whole outfit. The geyser threw out many rocks, some of them a foot square. I saw that geyser go off once after that. It was before a bridge was built.

EDWIN LINTON
ZOOLOGICAL LABORATORY,
UNIVERSITY OF PENNSYLVANIA

SPECIAL CORRESPONDENCE

THE ELLA SACHS PLOTZ FOUNDATION FOR THE ADVANCEMENT OF SCIENTIFIC INVESTIGATION

DURING the seventh year of the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation, seventy-eight applications for grants were received by the trustees, sixty-two of which came from twelve different countries in Europe and Asia, the remaining sixteen coming from the United States. The total number of grants made during this year was twenty-five, one of these being a continued annual grant. Twenty-one of the new grants were made to scientists in countries outside of the United States.

In the seven years of its existence, the foundation

[1] Since the above was written, several other reports have reached me of the finding of similar centipedes the past summer, including one in the gymnasium of the Chadron Normal College, at Chadron, Nebraska, reported to me by a student.—H. J. C.

has made one hundred and twenty grants and investigators have been aided in the United States, Great Britain, France, Germany, Austria, Hungary, Switzerland, Italy, Sweden, Esthonia, Czechoslovakia, Poland, Chile, Syria and Belgium.

The list of investigators and of the researches which have been aided in the current year is as follows:

Dr. George Barger, Edinburgh, $500 for chemical investigations of the alkaloids of ergot.

Professor Dr. Bohnenkamp, Würzburg, $500 for a new simple direct calorimeter.

Professor Dr. A. Bornstein, Hamburg, $400 for continuation of the study of the physiology and pathology of kidney function.

Professor Dr. M. Dennig, Heidelberg, $500 for continuation of work on rate of blood flow and breathing in sickness and in animals.

Dr. Emil Epstein, Vienna, $300 for investigations on Lipoid-Histocytosis.

Professor Carlo Foa, Milan, $500 for researches upon the normal and pathological metabolism of uric acid in dog and man.

Professor Otto Fürth, Vienna, $400 for study on the chemistry of proteins of the cell-nucleus, by Professor Otto Fürth and Theodore Leipert; and $400 for continuation of work on Urochrom-precursors in the urine and the blood serum by Professor Hermann Karl Barrenscheen.

Professor Paul Govaerts, Brussels, $500 for continuation of work on nephritis and edema.

Professor Paul Hari, Budapest, $500 for continuation of respiratory and metabolic experiments.

Professor J. P. Hoet, Louvain, $500 for investigation of insulin secretion and its physiological control.

Dr. Theodore Huzella, Debrecen, $400 for experimental investigations in different human and animal tumors.

Professor Dr. Erik Johannes Kraus, Prague, $150 for researches on the relationship of hypophysis and midbrain.

Professor Warfield T. Longcope, Johns Hopkins Hospital, $500 for studies on the experimental production of nephritis.

Professor Dr. Franz Lucksch, Prague, $300 for continuation of work on the tubercle bacilli.

Dr. David Marine, Montefiore Hospital, $500 for an attempt to separate the powerful goitrogenic agent present in cabbage.

Dr. E. B. McKinley, San Juan, $200 for continuation of work on experimental infection and immunity.

Professor Francesco Pentimalli, Rome, $250 for continuation of work on the nature of the agent of chicken sarcoma.

Dr. D. Scherf, Vienna, $250 for continuation of work on the "origin of extrasystoles."

Professor Dr. Carl Schlayer, Berlin, $250 for continuation of studies of the diuretic hormone contained in the brain.

Dr. E. A. Spiegel, Vienna, $400 for continuation of experiments on muscle tonus and on the central mechanism of epileptic fits.

Dr. A. Szent-Gyorgyi, Szeged, $500 for continuation of work on the chemistry and function of the adrenal cortex and biological oxidation.

Thorndike Memorial Laboratory, Boston City Hospital (Dr. George R. Minot, director), $500 in recognition of Dr. Peabody's services.

Professor Dr. Volhard, Frankfurt, $500 for continuation of studies on pathological kidneys.

Professor Dr. W. Weichardt, Wiesbaden, $250 for continuation of investigations on non-specific therapy.

Professor Edgard Zunz, Brussels, $500 for continuation of studies of pancreatic secretion.

In their first statement regarding the purposes for which the fund would be used the trustees expressed themselves as follows:

(1) For the present, researches will be favored that are directed towards the solution of problems in medicine and surgery or in branches of science bearing on medicine and surgery.

(2) As a rule, preference will be given to researches on a single problem or on closely allied problems; it is hoped that investigators in this and in other countries may be found, whose work on similar or related problems may be assisted so that more rapid progress may be made possible.

(3) Grants may be used for the purchase of apparatus and supplies that are needed for special investigations, and for the payment of unusual expenses incident to such investigations, including technical assistance, but not for providing apparatus or materials which are ordinarily a part of laboratory equipment. Stipends for the support of investigators will be granted only under exceptional circumstances.

In accordance with the policy outlined in paragraph 2, four of the investigations which have been aided in 1930 bear on the general subject of nephritis; in 1929 there were seven, in 1928 three, and in each of the four preceding years four grants for work in this same field. Other general subjects, especially internal secretion and infection, have been favored by grants in successive years, but not to so great a degree as nephritis.

Applications for grants to be held during the year 1930–1931 should be in the hands of the executive committee before May 1.

Applications should include statements as to the character of the proposed research, the amount of money requested, and the objects for which the money is to be expended.

Applications should be sent to the secretary, Collis P. Huntington Memorial Hospital, 695 Huntington Avenue, Boston, Massachusetts.

JOSEPH C. AUB,
Secretary

QUOTATIONS

ELLWOOD HENDRICK

A FRIEND can not be defined. He is never made: he comes, when and how who shall say? Only where the wind listeth. He can not be a woman: subtle, homosexual harmonies tie the relationship. He is the greatest and rarest of discoveries: the inestimable loss. The intensity of friendship may vary greatly: waiting as it does upon opportunity for its upgrowth, ripening with time, its character is of instant determination: at least, you know at once who are the people you will like.

Ellwood Hendrick, almost by his name, made instant appeal to me ten years or so ago when we met at one of our summer chemical gatherings. To write the common, catalogued, laudatory notice of such a man is impossible, the more as he has no base professional claim. When with him I had the feeling that "Rip van Winkle" was at hand, having Jefferson's inspired presentation of the delinquent in mind—a vision unfortunately impossible to the modern generation. Hendrick was a bit of a Rip and both in build and manner of Dutch complexion, with sufficient *Diable au corps,* I believe of Irish origin, to make him artist and humorist as well—no mere testubical chemist. Giving avuncular advice on the study of chemistry, he could slyly write—

You'd better join the Church before
  This course is well begun,
Because you'll need to exercise
  The art of faith, my son.

I used to think theology
  Was rather rough on doubt
But chemistry with ions beats
  Theology all out.

Long an admirer of Lafcadio Hearn—the strangest of hybrids, Greek-Irish by descent—in reading his "Life and Letters," by Elizabeth Bisland (1906), I had wondered what manner of man the Ellwood Hendrick could be to whom Hearn had addressed such wonderful outpourings, even calling him "Dear, Devilishly Delightful, Old Fellow" (in 1891). Hearn wrote his friend's epitaph in using these words. This is what I at once found him to be. We exchanged letters freely and it took me but a short time to fathom the secret of Hearn's love of the man. The full story of this friendship was given by Hendrick, in an essay he contributed to the *Bulletin* of the New York Public Library last year; he had presented the precious originals of the Bisland letters to the library in 1919.

Hendrick tells how he first met Lafcadio Hearn, in 1888, in New York, at a select gathering of literary people, including Elizabeth Bisland—the most beautiful woman he ever saw. Hearn was then on his return from two years in the French West Indies; this was a year before he went to Japan. Quickly seeing how utterly miserable Hearn was in the presence of strangers, owing to his intense shyness, accentuated by his partial blindness, Hendrick soon took him away—as an old Heidelberg Corps student should, naturally to "a none too respectable beer cellar," the only possible place of resort in the circumstances. The beer fulfilled its divine appointed purpose. They talked of many things. In the end Hendrick resolved that here was his opportunity:

> . . . that if this man would only let me, I would cultivate his friendship and be with him as much as I might, for it seemed as though, through him, a light was dawning on my horizon.
>
> Perhaps I had better explain a little about myself. I had studied chemistry abroad and had planned to organize a great synthetic organic chemical industry in the United States. It had started and proceeded for three years until we finally produced excellent materials. But our sales organization was defective, tariff changes and a bad year ensued; there arose disagreement among the proprietors, the bonds foreclosed and that was an end to it all for me. I was young and foolish and resolved to have nothing more to do with chemistry which had been, I felt, a false mistress to me. The dreams of my boyhood and young manhood were shattered, I believed my future to have been destroyed, that nothing but commonplace things would be available to me and that the whole business of living was hardly worth while. It was easy enough to make a living by sticking to my job but even if it did lead to a better post and more pay it lacked the distinction on which I had set my heart—and been disappointed. In short, my ambition was hardly to be recognized.
>
> I did not tell these things to Lafcadio as I have told them here but he sensed the situation. And just as I resolved that night to cling to this man in the hope of enlightenment, I believe he resolved to fan the almost extinct spark of ambition in his new companion, who was ten years his junior, until it might burn again and warm his disappointed soul.

Ellwood Hendrick was born at Albany, N. Y., on December 19, 1861; he died in his New York home on October 29, 1930. Educated for the most part abroad, at twenty he became manager of the Albany Aniline Dye Works—it is not surprising that he was unsuccessful. He then spent over thirty years in insurance work. He returned to chemical work, in 1917, with the Arthur D. Little Co., Cambridge, Mas-

sachusetts. In 1924, he was appointed curator of the Chandler Museum in Columbia University. Of late, he exercised a great influence upon the social development of Columbia students, seeking to make them men of the world. All sorts of willing helpers came to his aid—distinguished actresses and others. He had a very pretty pen, as all know who have his delightful volume of "Percolator Papers" (Harper Bros., 1919), a model in its way—named after the organ of the New York Chemists' Club. He could write on subjects so far apart as Saul of Tarsus and C_2H_5OH—even ascribe to the latter the greater influence for good in the world.

Hendrick was a perfect letter writer. Early in March of last year, he wrote me a rapturous account of "Green Pastures," the work of his friend Marc Connelly. "I'm so full of it, I want to write about it to some sympathetic soul." To him it was a wonderful picture of the way in which the "darkies" took the Bible and adjusted it to their own minds. (This may not be without repercussion upon ourselves, if we consider what is the effect upon students of text-book tarradiddles and modern pseudo-scientific mysticism.) "It is all real from a simple and childish point of view that everybody had once. I urge you to see it. It is free from all the offensiveness of apologetics." His charm, in fact, lay in his being himself a primitive. In "Green Pastures," Hendrick was in the element native to his spirit.—HENRY E. ARMSTRONG in *Nature*.

SCIENTIFIC BOOKS

The Migration of Butterflies. By C. B. WILLIAMS. Biological Monographs and Manuals, No. IX; Edinburgh and London: Oliver and Boyd, 1930, pp. xi + 473, 71 figs. (all diagrams and maps).

MR. WILLIAMS has been studying the subject of migration for a number of years and has written much about it. He has paid especial attention to the migration of butterflies. His successive residences in England, United States, British West Indies, Egypt and East Africa have given him unusual opportunities for observations, and he has not only made the most of these opportunities but has corresponded largely with naturalists in different parts of the world and has collected the literature of the subject very carefully.

The present volume is painstaking and full. The actual evidence in regard to each species is displayed with great care and detail in the first 312 pages. Part IV of the book, which gives a general discussion, is both interesting and important. It contains chapters on the true nature of migratory flights, on the condition and the behavior of the migrants, the conditions determining the start of the flight, and the determination of route and goal. Then follows a chapter on comparison with other animals, in which dragon-flies, locusts and other insects, birds, mammals and fishes are considered. And then there is added a chapter on general problems, with another which contains a summary, conclusions and suggestions for further work. The bibliography is extensive and covers 26 pages of fine type. The format of the book is admirable. Other monographs in this series are probably well known to workers. The general editors, as is well known, are F. A. E. Crew, of Edinburgh, and D. Ward Cutler, of Rothamsted. The object of the series is an admirable one, namely to provide authoritative accounts of what has been done in some of the diverse branches of biological investigation and at the same time to give those who have contributed notably to the development of a particular field of inquiry the opportunity of presenting the results of their researches, scattered through the scientific journals, in a more extended form, showing their relation to what has already been done and to the problems that remain to be solved.

As Mr. Williams states in his introduction, he has not included in his book any entirely new records of migration not published elsewhere. The work, however, brings the subject quite down to date, and it is done in a masterly way by a broad and very competent student.

L. O. HOWARD

BUREAU OF ENTOMOLOGY

Barlow's Tables of Squares, Cubes, Square Roots, Cube Roots and Reciprocals of all Integer Numbers up to 10,000. Third edition. Revised and enlarged by DR. L. J. COMRIE. Pp. xii, 208. E. and F. N. Spon, London, 1930.

PETER BARLOW'S TABLES will need no introduction to many of the scientists who have found it desirable to use a calculating machine in their work. These tables originally appeared in 1814; a new incomplete edition was edited by Augustus de Morgan in 1840. Since then, an ever-increasing demand for the book has led to many printings from the stereotype plates of 1840.

It is very fortunate that the present revision of these tables has been carried out by Dr. Comrie. His expert knowledge of the efficient use of calculating

machines and his wide experience in the construction of tables fitted him well for the task.

It will not be necessary to go into great detail regarding the content of this book since the title gives a very good idea of the principal tables. The present edition retains all the valuable features of the first two editions, and in addition contains certain new tables. Among the latter may be mentioned factorial n up to n = 100, and n^4 and $1/\sqrt{n}$ up to 1,000. For the integers between 1,000 and 10,000, inclusive, $\sqrt{10n}$ is given in addition to the usual $\sqrt{n}$. The powers up to the tenth of the first hundred integers and powers up to the twentieth of the first ten integers are given.

Interpolation in the tables of square roots, cube roots and reciprocals is facilitated by the provision of interlinear first differences. The square roots and cube roots have been cut to eight significant figures, a number sufficient for practically all purposes. The computer will appreciate the fact that the publishers have chosen to use clear, easily-read modern type and a good grade of paper.

Charles H. Smiley

Brown University

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONVENIENT HYDROMETER FOR DETERMINING THE SPECIFIC GRAVITY OF HEAVY LIQUIDS

The separation of minerals from loose aggregates by using liquids of high specific gravity is a common practice in the study of a variety of sedimentary rocks. Frequently only one cut is made of the aggregate, the desire being to separate the heavy minerals, or those with a specific gravity of about 2.8 and above, from the more common quartz. In such a case bromoform that will float quartz is satisfactory, and the quickest test of density is to drop a grain of quartz in the liquid. In other cases it may be desirable to make cuts between the quartz and some of the feldspars, and then the extreme heavies; or between the quartz and the carbonates; or many other cuts at a variety of values of specific gravity. In such cases it is necessary to know the exact specific gravity of the liquid used, and to control the dilution when preparing a liquid for a specific separation.

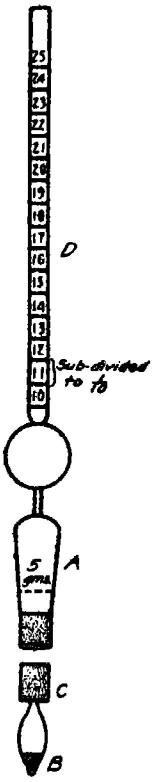


Fig. 1

Various methods have been used by the writer in making specific gravity determinations of heavy liquids. A small picnometer has been used with good success, but the method is tedious and time-consuming. Eimer and Amend, of New York, on the suggestion of the writer, recently prepared a new type hydrometer with which the specific gravity of a liquid between 2.000 and 5.000 can be determined accurately and quickly in one operation. A distinct advantage of the apparatus is that only 5 cc of the liquid is needed for a test. When mixing liquids in small quantities to obtain a required specific gravity, quick determinations are possible with this instrument.

The hydrometer is made of glass tubing with a ball float near one end and just above a liquid chamber *A*. Fig. 1 shows the hydrometer in the inverted position as it is placed in a column of water and the scale is read. A small amount of mercury *B* is used as a balancer, and is sealed in the glass stopper *C* which fits in the liquid chamber. A scale *D* with graduations from ten to twenty-five grams, sub-divided in tenths, is contained in the long glass rod. The liquid chamber or cylindrical bulb is marked to show the level of five grams of distilled water at 20° C. The glass stopper is ground for tight fitting when the hydrometer is inverted in a cylinder of water.

To determine the specific gravity of a liquid which is between 2.000 and 5.000, the liquid chamber *A* is filled with the liquid to the level marked on the bulb, the stopper put in place securely, and then the whole is inverted and floated in distilled water in a tall cylinder. A 1,000-cc cylinder of six or seven cm diameter is satisfactory. The bottom of the meniscus of the water is read on the graduated scale of the long glass tube and this value divided by five (the gram units of the water capacity of the bulb) gives the specific gravity of the liquid.

The instrument may be used for the determination of gravities of solid particles as well, the usual weighing in air and weighing in water being necessary, the balance being the float of the hydrometer in the water. Only two operations and measurements are necessary. (1) Place the solid mineral or rock particle (air dry) in the specimen bulb (which is the liquid chamber *A*), insert stopper and float in the column of water. The value read is the weight of the specimen in air. (2) Put distilled water in the specimen chamber up to the 5 cc mark, and again make a reading with the instrument floating in the column of water. This value is the weight of the

specimen in water. Since the weight of the water displaced by the solid particle is the equivalent of the buoyant force on the solid body, and the known capacity of the specimen chamber is five grams of distilled water, the amount of water displaced, or the loss of weight of the specimen weighed in water, is readily determined and the specific gravity of the particle calculated. An example of the calculations is given below:

Weight of dry specimen in chamber	14.3 gm
Weight of full chamber of water	5.0
Total, specimen alone, and water alone	19.3 gm
Weight of specimen in water to the 5 gm marks on bulb	15.6 gm
Amount of water displaced	3.7 gm

Specific gravity $= \frac{14.3}{3.7} = 3.86$

The size of the hydrometer may be a hindrance to some workers. If such is the case, a model one half the length and volume may be used, but for the same range of specific gravity the results will be less accurate.

A. C. TESTER

STATE UNIVERSITY OF IOWA

REPAIR OF NON-CONDUCTIVE GALVANOMETER STRINGS[1]

THE gilded quartz fibers used in the string galvanometer sometimes lose conductivity without actually breaking. Such fibers may generally be repaired without removing them from the galvanometer. The break in the metallic coating may be located by the use of a single dry cell and a pair of high-resistance head phones. The negative pole of the battery is connected to a string terminal, and under a bright light the string is gently touched at increasing distances from this terminal with a light copper wire connected to the other pole of the battery through the head phones. When the point is reached where a click is no longer heard in the phones, the battery is connected to the opposite string terminal and the process is repeated from the other end to ascertain if the break is confined to one point.

The break in the metallic coating having been located, both string terminals are connected. The repair is then easily made by wetting the positive copper wire with copper sulphate solution and touching the string at the break. Electrolytic deposition of copper will usually restore the conductivity of the string.

Should the break occur exactly under the lenses of the galvanometer microscopes, the slightly roughened string surface where the repair was made may be displaced upward or downward by shifting the entire string by means of a string holder. Ordinarily the repaired strings are not appreciably changed from their original resistance.

CHESTER W. DARROW

[1] Report from the Behavior Research Fund, Chicago: Series B, No. 170.

A SIPHON MOIST CHAMBER FOR MICROSCOPIC MOUNTS

FOR several years the writer has used a method for keeping a water mount continuously supplied with water. The arrangement is so simple that it seems probable that it has been previously used and described and, although the method is original with the writer, no claim of priority is made since it has not seemed worth while to make a canvass of literature. The present note is given to recommend its more general use.

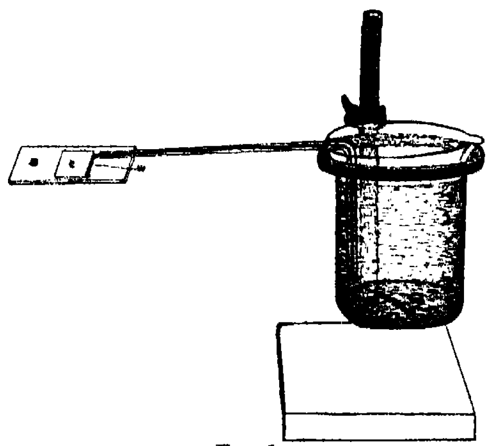


FIG. 1

A glass tube about 25 mm, or less, with a bore of about 4 mm, is bent at right angles about 8 mm from one end. With the aid of a wire, a cord having the texture of candle wick is pulled through the tube leaving about 1½ mm of the cord extending beyond the long arm and several millimeters beyond the short arm of the tube. The cord is thoroughly wet and the end of the short arm with projecting wick is immersed in a beaker of water. The beaker is suspended in a metal ring which is attached to a ring stand so that the beaker may be raised or lowered. The long arm of the tube is supported by the rim of the beaker and its end rests on the slide (s), close to the edge of the cover-glass (c), which is preferably square. The short end of the wick (w) is pressed against one side of the cover-glass. The beaker can be so adjusted that a perfect balance of the flow of water through the wick and evaporation of water from the mount can be maintained so that water is under the entire cover-glass and none extends beyond its edge. If the beaker is elevated too high the slide will become flooded, and if too low the mount will become

dry. A mount can be made in a nutritive solution and with this method the concentration will not be changed. The tube and beaker of water can be sterilized so that the mount will keep in good condition for several days though the length of time will depend on whether it has been made from pure culture or fresh material. If the tube is properly elevated there will be no water current so that this method is also favorable for photomicrographic work.

FLORENCE A. MCCORMICK

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

SPECIAL ARTICLES

SOME PECULIARITIES IN THE THERMO-ELECTRIC PROPERTIES OF MONEL METAL

IT has been shown by Tait[1] and by Belloc[2] that there is a very close relationship between the magnetic and the thermoelectric properties of certain ferromagnetic substances. For iron and nickel there is a maximum in the $\frac{dE}{dT} - T$ curve at the same temperature as that at which the substance loses a large part of its ferromagnetic properties. Sometimes this maximum serves to locate the critical temperature with greater accuracy than is possible from measurements on permeability or magnetostriction.

The specimens studied in the present investigation were two rods of monel metal about 60 cm long. The one designated as Rod No. 31 was approximately 0.65 cm in diameter, while Rod No. 32 was approximately 0.48 cm in diameter. The permeability and magnetostriction in both these rods had been investigated by others[3] and the thermoelectric method was tried in the hope that it might afford a more accurate determination of the critical point.

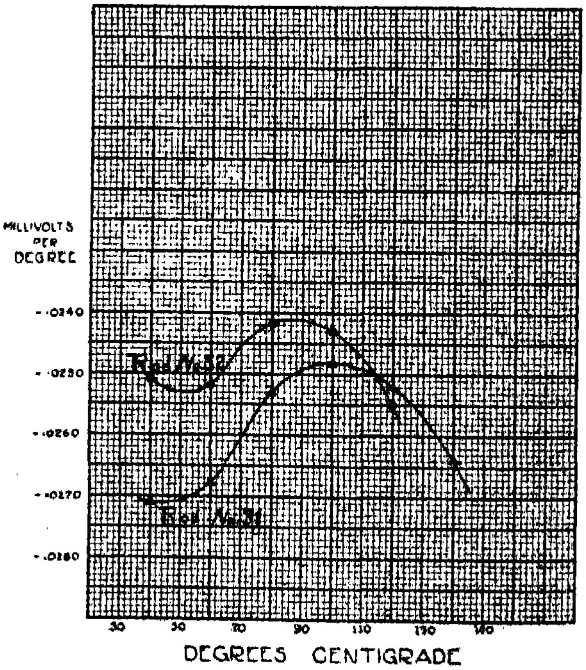
Each rod was joined at one end to a suitable length of lead wire to form a lead-monel metal thermocouple. The couple under test, together with a chromel-alumel couple, was mounted so that the "hot junctions" could be heated in an electrically heated oil bath while the "cold junctions" were maintained at 0° C. in a suitable ice bath. The leads from the cold junctions were connected to a potentiometer through a double-pole, double-throw switch so that readings of the e. m. f. for the two couples could be taken alternately at short intervals. The temperature of the oil bath was raised at the rate of about 2 to 2.5° C. per minute and the e. m. f. of each thermocouple was read every minute. With this rate of heating, the temperature can be considered as a linear function of the time for short periods and, hence, the temperature of the lead-monel metal couple at the time that its e. m. f. was observed was obtained by interpolation from the readings on the chromel-alumel couple.

[1] P. G. Tait, *Proc. Roy. Soc. Edin.* 7, 597, 1871.
[2] G. Belloc, *Ann. de chim. et de phys.* 30, 42, 1903.
[3] D. R. Inglis, *Instruments*, 2, 129–132, 1929.

In the following table the average values $\frac{dE}{dT}$ are given as computed from these data for intervals of $dT = 20°$ C. The use of smaller intervals for dT, although desirable, did not seem to be warranted by the accuracy of the data and method.

Interval	Mean temperature, T° C.	$\frac{dE}{dT}$ in millivolts per degree Rod No. 31	Rod No. 32
30– 50°	40°	−0.0271	−0.0251
50– 70°	60°	−0.0267	−0.0252
70– 90°	80°	−0.0253	−0.0242
90–110°	100°	−0.0248	−0.0243
110–130°	120°	−0.0252	−0.0255
130–150°	140°	−0.0264	

When these results are plotted, as in the accompanying figure, the maxima are quite definite, at



100° C. for Rod No. 31 and at 87° C. for Rod No. 32. The number of observations made does not justify claiming an accuracy of better than 2 or 3 degrees

for these points, so that the results are to be regarded as qualitative rather than quantitative. It should be noted that Rod No. 31 exhibits a greater change than Rod No. 32. This is in agreement with previous observations[4] on the permeability and magnetostriction of these rods which showed that Rod No. 31 is more ferromagnetic than Rod No. 32.

The author is very much indebted to Professor S. R. Williams for suggesting the problem and to Professor W. W. Stifler for valuable advice and assistance in carrying out the experimental work and in preparing the results for publication.

EMERY MESCHTER
FAYERWEATHER LABORATORY OF PHYSICS,
AMHERST COLLEGE,
AMHERST, MASSACHUSETTS

STROPHANTHIN. XIX. THE DEHYDROGENATION OF STROPHANTHIDIN AND GITOXIGENIN

IN the course of our investigation of the structure of the cardiac aglucones a number of these substances have been submitted to the action of dehydrogenating agents with the hope of obtaining reaction products which would point to the structure of the fundamental hydrocarbon skeletons upon which these aglucones are built. Following preliminary inconclusive experiments with platinum black and sulfur, the use of the selenium method of Diels, Gädke and Körding[1] has been employed and has given results of a more promising character. The preliminary observations with strophanthidin and gitoxigenin are as follows.

STROPHANTHIDIN

A mixture of 45 gm of strophanthidin and 65 gm of selenium was heated in an atmosphere of nitrogen for 45 hours at 330–340°. The chloroform extract of the reaction mass yielded a thick oil. A preliminary distillation of this material at 2 mm gave 12.3 gm of semi-crystalline substance which when refractionated at 2 mm gave the following hydrocarbon fractions.

Fraction I. –190°. 1.9 gm of a thick yellow oil which crystallized only partially on standing.

Fraction II. 190–210°. 3.9 gm of partly crystalline material.

Fraction III. 210–230°. 1.9 gm mostly crystalline.

Fraction IV. 230–250°. 1.6 gm mostly crystalline.

Fraction I gave a picrate in alcoholic solution which after recrystallization from an alcoholic picric acid solution was reconverted into the hydrocarbon. This separated at first from alcohol as shining plates which melted at 112–115°. After four recrystallizations from alcohol the melting point was raised to 130–134°. Analysis gave C 92.99, 93.26; H 6.55, 6.88. Calculated for $C_{18}H_{16}$: C 93.05, H 6.95.

The molecular weight determined in camphor gave 228, 212. Calculated for $C_{18}H_{16}$: 232.

Fraction II, after pressing off the oil, gave plates from alcohol which at first melted at 180–195°. After successive recrystallizations from alcohol, acetic anhydride and benzene it melted at 230–237°.

Analysis gave C 93.29, 93.34; H 6.09, 5.92.

Fraction III, after pressing off adhering oil and recrystallizing from alcohol, first melted at 195–210°. After repeated recrystallizations from acetic anhydride, benzene and finally thiophene it melted at 240–245°.

Analysis gave C 93.64, 93.41; H 6.29, 6.25.

Fraction IV was obtained as plates from alcohol. After repeated recrystallization from acetic anhydride, alcohol and thiophene a faintly yellow substance was obtained, which melted at 285–292°. This hydrocarbon was practically insoluble in alcohol, ether, petroleum ether and acetone.

Analysis gave C 93.66, 94.00; H 5.71, 6.04. Calculated for $C_{23}H_{18}$: C 93.83, H 6.17.

The molecular weight determination gave 310, 315. Calculated for $C_{23}H_{18}$, 294.

GITOXIGENIN

When gitoxigenin was dehydrogenated with selenium about 20 per cent. of its weight of hydrocarbon was recovered. This was separated roughly into two fractions. The lower fraction was an oil which slowly and incompletely crystallized. This was converted first into a picrate which after recrystallization was reconverted into the hydrocarbon. After two recrystallizations from alcohol, platelets were obtained which melted at 135–150°.

Analysis gave C 92.80, H 6.45.

Fraction II was partly crystalline. The oil was pressed off. Recrystallization from alcohol gave platelets which melted at 195–210°. After several recrystallizations from acetic anhydride it melted at 223–230° and resembled closely in solubility and crystalline form the so-called $C_{23}H_{18}$ hydrocarbon obtained from strophanthidin.

Analysis gave C 93.70, 93.86; H 6.25, 6.06.

Owing to the great difficulties attending the isolation of homogeneous individuals from mixtures of hydrocarbons, especially where the amounts available are so limited, the observations here given may be

[4] S. R. Williams, *Phys. Rev.* 29, 370, 1927, and D. R. Inglis, *loc. cit.*

[1] O. Diels, W. Gädke and P. Körding, *Ann. d. Chem.*, 1927, 459, 1.

regarded only as preliminary and can only suggest the general nature and probable molecular size of these substances. Further work is in progress, the results of which will be described in detail elsewhere.

WALTER A. JACOBS
ELMER E. FLECK

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

THE FAUNA OF THE MIDDLE DEVONIAN BEAUVAIS SANDSTONE OF MISSOURI

THE complexly faulted Little Saline Creek area of Ste. Genevieve County, Missouri, has been the site of one of the University of Chicago's geological field camps for nearly twenty summers. During the course of detailed field mapping students and instructors alike have, from year to year, continued to find new structural and paleontological features, many of which have proved to be of more than local interest. One of the early discoveries was the fact that a brown, sugary sandstone, which had been called the St. Peter by some geologists, was in reality very much younger than that formation. This sandstone, which proved to be only one of a complete sequence of lower and middle Devonian formations preserved in a downfaulted block, was early designated by Weller as the Beauvais formation. His detailed description of the sandstone, however, did not appear until posthumously in 1928.[1]

The stratigraphic position of this sandstone between the Onondagan Grand Tower limestone and the Hamilton St. Laurent formation having been determined, its mid-Devonian age was established. Its exact correlation with other deposits of somewhat similar age, however, has been difficult because of its essential lack of well-preserved organic remains. According to Weller, fossils are rare in the formation and have been observed only at an outcrop on the Little Saline Creek near the Boarman School road. At this locality a number of species of invertebrates are represented by poorly preserved internal casts. The only species which is at all common is one identified as *Newberrya claypolei;* the condition of the others does not permit their identification. Branson and Williams,[2] however, five years earlier listed the following species from the Beauvais sandstone:

Atrypa reticularis (Linnaeus)
Chonetes vicinus (Castelnau)
Schizophoria striatula (Schlotheim)
Spirifer granulosus (Conrad)
Stropheodonta demissa (Conrad)
Tentaculites sp.

No locality is given for these species, but as Branson and Williams say that the specimens studied "were collected" and "most of the species were identified by Professor Weller's students before they were sent to the writers . . ." we may assume that they came from the locality mentioned above, and that Professor Weller felt that the identifications were none too certain.

One of the interesting discoveries of the field season of 1930 was the fact that the Beauvais sandstone is fossiliferous at other localities than that previously mentioned. One of these borders the old road on the south side of Peach Tree Ridge almost directly north of the Boarman School; a second is situated along the southern side of the triangular fault block of Beauvais near the top of the above-mentioned ridge, and the third occurs near the northern apex of the easternmost Beauvais fault block on Troublesome Hill, not far west of the Ozora-St. Mary's road. All three of these localities are at or near fault lines where the sandstone, as a consequence, is somewhat better cemented than usual. As a further result the fossils are more readily identifiable than is the case of those taken from Weller's locality, though it must be admitted that the preservation is not very good. A study of the material from these localities makes it possible to list the following assemblage as the known Beauvais fauna:

Favosites (several species)
Crinoid stems
Bryozoan (dichotomous branching)
Orbiculoidcs lodiensis var. *media?* (Hall)
Crania crenistriata Hall
Stropheodonta demissa Conrad
Leptaena rhomoboidalis (Wilckens)
Chonetes vicinus (Castelnau)
Camarotoechia sp.
Cyrtina sp.
Schizophoria striatula (Schlotheim)
Atrypa reticularis (Linnaeus)
Athyris fultonensis Swallow
Spirifer granulosus (Conrad)
" *pennatus* (Atwater)
" *varicosus* Hall
" sp.
" n. sp.
Nucula sp. 1
" sp. 2
Nuculites oblongatus Conrad
Palaeoneilo maxima (Conrad)
Pterinea flabellum (Conrad)
Actinopteria boydi Hall
Leiopteria cf. *gabbi* Hall
Modiomorpha sp. 1
" sp. 2

[1] Missouri Bureau of Mines and Geology, 22 (1928): 148–50.
[2] E. B. Branson and J. S. Williams, Missouri Bureau of Mines and Geology, 17 (1923): 131.

Paracyclas elliptica Hall
Platyceras cf. *reflexum* Hall
Tentaculites bellulus Hall
Nephriticeras (unnamed species found in Grand Tower)
Bactrites? aciculum? Hall
Proetus crassimarginatus Hall
" cf. *haldemani* Hall
Phacops cf. *cristata* Hall
Ostracodes (several species)
Onychodus sigmoides Newberry

No apology is made for the lack of specific identification in some instances and the indicated uncertainty in others, nor is the faunal list considered complete. The identification of most of the species given, however, is thought to be correct in spite of the imperfect preservation of much of the material upon which determinations were based.

Of the twenty-three forms specifically identified or referred to species, twelve are also found in the Grand Tower fauna, five are known from the St. Laurent, one is found in the Onondaga division of the Romney of Maryland, two in the Hamilton division of the Romney, and three in the Hamilton of New York. The paleontologic evidence, therefore, indicates a fauna transitional between the Grand Tower and the St. Laurent. In other words, the Beauvais fauna shows both Onondagan and Hamilton affinities. Thus the formation is doubly unique in that it has neither exact lithologic nor paleontologic equivalents in the Devonian of the North American interior, although its stratigraphic position is similar to that of the Marcellus shale of New York. The intermediate character of the fauna may be taken as proof of the fact that the Beauvais sandstone is essentially conformable with the enclosing formations, although the actual contacts have not been seen. The lithologic evidence also supports this conclusion, for the upper Grand Tower limestone contains sand grains of the Beauvais type in increasing amount upward, and the lower St. Laurent beds are also more arenaceous than the higher strata.

Because of the distinctly intermediate character of the fauna and the intricacies of the fault patterns, a natural question is: has the fauna described an intermediate aspect because of the fact that some of the material collected was actually taken from the more arenaceous phase of the Grand Tower and mixed with other material from the lower St. Laurent? The answer is that such a mixture is most improbable for (1) no St. Laurent has ever been identified near any of the three localities here described; (2) the matrix is in each locality entirely non-calcareous, which is not the case of either the arenaceous Grand Tower or St. Laurent, and (3) almost all the species listed above may be collected from a single large block of the sandstone at the locality near the top of Peach Tree Ridge.

CAREY CRONEIS
ARNOLD D. HOFFMAN

WALKER MUSEUM,
UNIVERSITY OF CHICAGO

RESPONSES OF SHEEP TO ZYGADENUS GRAMINEUS, "DEATH CAMAS"

MORE than a quarter of a century ago the symptoms produced in sheep after eating *Zygadenus gramineus* or "death camas," one of the most noxious plants growing upon the ranges of Colorado, Montana and Wyoming, were observed and recorded by Chestnut and Wilcox,[1] and quite similar responses were noted by Marsh and Clawson[2] during the forced feeding experiments conducted by them. Laboratory studies were made upon the alkaloidal principles of this plant and the reactions produced in laboratory animals following their administration by Reid Hunt,[3] Torald Sollmann[4] and by Mitchell and Smith.[5]

The annual loss of great numbers of sheep after having eaten of this plant has prompted a further study of the action of the active principles of this plant upon these animals in order to secure all data possible respecting the point and mode of action of these principles.

A fluid extract made from the dried herbage of this plant was dried upon spent marc and extracted with petroleum and ethyl ethers in order to remove resins present in the original extract. The remainder of the extract was percolated with 90 per cent. alcohol, which later was evaporated by means of gentle heat, and the semisolid residue was taken up in dilute alcohol and filtered. This filtrate, which was employed for intravenous injections, contained 0.004 gram of alkaloids per cubic centimeter in a solution of 21 per cent. alcohol.

The four sheep employed for these experiments were anesthetized with ether followed by a solution of amytal given intravenously. It was found necessary to supplement the dosage generally used for laboratory animals with a 20 per cent. solution of urethane in Locke's solution given intravenously or by chloretone in oil injected intraperitoneally. Chloretone in oil alone was unsatisfactory. The intravenous injections were made by way of one of the

[1] Chestnut and Wilcox, Bulletin No. 26, Division of Botany, U. S. Dept. of Agriculture, pp. 51–64, 1901.

[2] Marsh and Clawson, Bulletin No. 125, Professional Papers, U. S. Dept. of Agriculture, 1915.

[3] Reid Hunt, *Am. Jour. Physiol.*, 6: xix–xx, 1902.

[4] Torald Sollmann, see Marsh and Clawson, p. 8.

[5] Mitchell and Smith, *Am. Jour. Physiol.*, 28: 318, 1911.

veins located on the lateral aspect of the tibio-tarsal or hock joint.

After complete immobility was secured, these sheep were connected with the instruments generally used for making graphic records of circulatory and respiratory movements. Sheep of from 55 to 69 pounds weight recovered spontaneously after the intravenous injection of 0.4 to 0.8 cc of the extract despite the inhibition of respiration lasting from one to several seconds.

Almost immediately after the injection of one cubic centimeter of the extract there occurred an apnoea of 20 seconds followed in turn by a few irregular, shallow respiratory movements and another period of apnoea which was accompanied by an elevation of 50 mm in blood-pressure. This rise of blood-pressure was brought back to normal after a short period, 10 to 12 seconds, of artificial respiration only to be followed two minutes later by another period of apnoea enduring for a full minute. Altogether there occurred four asphyxia-like rises of blood-pressure, varying from 44 to 108 mm of Hg above the previous normal, whose inceptions were preceded by apnoea enduring from one third to one minute before the animal recovered. These asphyxia-like rises of blood-pressure were always reduced to normal by means of artificial respiration, following which, except in the fourth case, there occurred irregular respiratory movements, displaced in their turn by a succeeding apnoea.

The circulatory system of sheep responds to intravenous injections of the extracts of *Zygadenus gramineus* in one of several ways. In the majority of instances there is a rise of blood-pressure accompanied by an acceleration of the cardiac rate. Some of the responses showed little if any change, and still others showed a fall in blood-pressure. In two instances in which a depression of blood-pressure occurred there was very little change in heart rate, indicating a vasodilation. This condition was frequently seen in similar experiments performed upon dogs and rabbits. The latter asphyxial rises of blood-pressure are undoubtedly of a secondary nature.

Believing that the chief toxic action of *Zygadenus gramineus* for sheep was in its great power for depressing the respiration, thus causing asphyxia, the writer, after an hour had been allowed for the animal to recover from the effects of an intravenous injection of the extract, closed the tracheal cannula and produced a graph very similar to one of the asphyxial rises of blood-pressure described above. When extracts of *Zygadenus gramineus* have been injected intraperitoneally or given by means of the stomach tube to rabbits, evidence of asphyxia, such as gasping and convulsive struggles associated with oxygen want, have been observed.

In his experiments with the alkaloidal substances isolated from Zygadenus Reid Hunt[3] found that caffein or diuretin given to rabbits and sheep in conjunction with large amounts of the alkaloidal materials caused such a rapid excretion of these toxic substances that no symptoms of poisoning resulted. The writer has observed that, after intramuscular injection of one grain of caffein dissolved in physiological salt solution with the aid of sodium benzoate, five times as much of the extract of Zygadenus was required to elicit the same response to this extract from a rabbit as was needed before the injection of the caffein. A sheep, following an intravenous injection of an extract of Zygadenus, exhibited a respiratory rate and amplitude of 53.6 and 1.9, respectively. A recovery to 42.1 and 11.6 mm, respectively, was recorded three minutes after the injection of one grain of caffein sodio-benzoate. These results and others of a similar nature furnish supplemental evidence to the findings of Hunt relative to the value of caffein as an antidote for animals poisoned by this plant.

SUMMARY

An extract of *Zygadenus gramineus*, "death camas," from which most of the resins had been removed was given intravenously to sheep prepared for recording blood-pressure and respiratory movements.

Following the intravenous injection of this extract there occurred a respiratory inhibition which in the case of the injection of larger amounts of the extract was followed by asphyxia-like rises of blood-pressure.

The graphic record of this asphyxial condition was practically duplicated by closing the tracheal cannula for a short time following the recovery of the animal from the effects of the plant extract.

Although, from a field standpoint, no satisfactory antidote has been found, it has been demonstrated that caffein sodio-benzoate possesses marked powers of stimulation for the respiratory center affected by the depressive substances found in *Zygadenus gramineus*.

ALVAH R. MCLAUGHLIN
UNIVERSITY OF WYOMING

BOOKS RECEIVED

BOWEN, R. SIDNEY, JR. *Flying from the Ground Up.* Pp. vi + 234. McGraw-Hill. $2.00.

Carnegie Institution, Year Book, 1930. No. 29. Pp. xix + 454. Carnegie Institution.

COLE, F. J. *Early Theories of Sexual Generation.* Pp. x + 230. Illustrated. Oxford University Press. $6.00.

IMMS, A. D. *Recent Advances in Entomology.* Pp. viii + 374. Illustrated. Blakiston. $3.50.

LEITH, C. K. *World Minerals and World Politics.* Pp. xii + 213. McGraw-Hill. $2.00.

REICHE, FRITZ. *The Quantum Theory.* Pp. viii + 218. Revised edition. Dutton. $2.10.

SCARBOROUGH, JAMES B. *Numerical Mathematical Analysis.* Pp. xiv + 416. Johns Hopkins Press. $5.50.

SPECIAL ISSUE CONTAINING REPORTS OF THE FOURTH CLEVELAND MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES. EDITED BY BURTON E. LIVINGSTON, PERMANENT SECRETARY.

SCIENCE

VOL. LXXIII FRIDAY, FEBRUARY 6, 1931 No. 1884

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORTS OF THE FOURTH CLEVELAND MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES

GENERAL FEATURES

THE fourth Cleveland meeting of the American Association was held from Monday, December 29, 1930, to Saturday, January 3, 1931. This was the eighty-seventh meeting of the association. Earlier Cleveland meetings were in July, 1853 (when the association was only five years old); in August, 1888; and in convocation week, 1912–13. The preliminary announcement of the fourth Cleveland meeting appeared in a special issue of SCIENCE for November 28, 1930, and the general program was published at Cleveland on Monday, December 29. Copies of the program may be secured free from the Washington office of the association.

The sessions for the natural and exact sciences were held mainly in the rooms of Western Reserve University and the Case School of Applied Science. The societies in the field of the social and economic sciences held their sessions in the hotels. These made their own local arrangements and operated their own registration offices, but the other organizations cooperated cordially with the association in the usual manner. The facilities were excellent and the meeting was successful in every way.

The president for this Cleveland meeting was Thomas H. Morgan, of the California Institute of Technology, eminent zoologist and a leading authority in the field of genetics. The retiring president was Robert A. Millikan, of the California Institute of Technology, leader in physical research and in the scientific education of the public. Dr. Millikan's retiring presidential address was given at the opening session of the meeting, on Monday evening, December 29, before an audience of over 3,000 people that filled the Cleveland Music Hall. Several hundred late comers were unfortunately unable to enter the hall. This

was the largest audience ever assembled for an opening session of the American Association. Dr. Millikan spoke on "Atomic Disintegration and Atomic Synthesis." His address has been published in SCIENCE for January 2, 1931.

REGISTRATION

Two thousand six hundred and thirty-five persons registered at the association's registration offices, in the gymnasium of Western Reserve University, and we are informed by the Cleveland Convention Board that 2,123 persons registered in the downtown hotels for the sessions devoted to the social and economic sciences and related fields. The total registration for all these meetings was therefore 4,758, of which number 413 represents people residing in Cleveland. There were of course many who attended some lectures or sessions who failed to register in either group of organizations. The residence distribution of those who registered with the American Association for the Advancement of Science is shown by the accompanying list. Altogether the attendance at Cleveland may be safely estimated as well above 5,000.

About 300 scientific sessions are shown in the American Association's General Program for this meeting, which also shows about 1,830 papers and addresses, given by about 2,090 authors; many contributions were by two or more joint authors. The papers were distributed among the sciences approximately as follows: Mathematics, 102; physics, 100; chemistry, 14; astronomy, 22; geology and geography, 23; zoology, 428; botany, 279; ecology, genetics, etc., 158; anthropology, 68; psychology, 22; social and economic sciences, 257 (not all these programs were made available for printing in the general program); historical and philological sciences, 13; engineering, 10; medical sciences, 5; agricultural sciences, 232; education, 43; science in general, 26. Many society dinners, luncheons and smokers were held, with excellent attendance.

REGISTRATION AT THE OFFICES OF THE A. A. A. S. BY STATES AND PROVINCES

Alabama	6
Arizona	7
Arkansas	3
Australia	1
California	42
Chile	1
China	2
Colorado	13
Connecticut	40
Cuba	2
Czechoslovakia	1
Delaware	10
District of Columbia	104
England	3
Florida	18
Georgia	13
Idaho	1
Illinois	155
India	1
Indiana	75
Iowa	62
Kansas	23
Kentucky	28
Louisiana	19
Maine	12
Manitoba	4
Maryland	47
Massachusetts	105
Michigan	153
Minnesota	47
Mississippi	15
Missouri	67
Montana	5
Nebraska	16
New Brunswick	1
Newfoundland	1
New Hampshire	11
New Jersey	55
New Mexico	2
New York	318
North Carolina	17
North Dakota	6
Ohio (Cleveland excluded)	348
Cleveland	252
Oklahoma	21
Ontario	32
Oregon	3
Pennsylvania	208
Poland	1
Porto Rico	3
Quebec	7
Rhode Island	16
Russia	3
South Carolina	12
South Dakota	2
Switzerland	1
Tennessee	25
Texas	24
Utah	4
Vermont	5
Virginia	36
Washington	9
West Virginia	28
Wisconsin	83
Wyoming	5
Total	2,635

THE CLEVELAND COMMITTEES

The general local committee on arrangements was unusually efficient this year. The committee was not organized till very late and most of the preparations were accomplished in the two months preceding the meeting, with the very active and able leadership of Dr. Harry W. Mountcastle, of Western Reserve University. The permanent secretary has learned of no serious complaints or criticisms of the work of the general committee or its subcommittees, which indicates that the members of the numerous organizations and groups were generally very well satisfied. To the members of the general committee and the subcommittees and to the local representatives of the association sections the American Association and all the societies that met with it are deeply and lastingly grateful. The personnel of the general committee is shown below.

THE GENERAL LOCAL COMMITTEE

ROBERT E. VINSON, *honorary chairman;* Western Reserve University.

WILLIAM E. WICKENDEN, *honorary vice-chairman;* Case School of Applied Science.

HARRY W. MOUNTCASTLE, *general chairman of the local committee and chairman of the special committee on meeting places;* Western Reserve University.

SIDNEY S. WILSON, *chairman of the special committee on finance;* Western Reserve University.

WINFRED G. LEUTNER, *chairman of the special committee on transportation, hotels, registration and communication;* Western Reserve University.

DAYTON C. MILLER, *chairman of the special committee on general sessions and public lectures;* Case School of Applied Science.

HOWARD T. KARSNER, *chairman of the special committee on entertainment;* Western Reserve University.

THEODORE M. FOCKE, *chairman of the special committee on equipment;* Case School of Applied Science.

HENRY B. DATES, *chairman of the special committee on exhibitions;* Case School of Applied Science.

J. PAUL VISSCHER, *chairman of the special committee on luncheons and dinners;* Western Reserve University.

CHARLES F. CHAPMAN, *chairman of the special committee on press relations;* Case School of Applied Science.

ORGANIZATIONS THAT MET IN CLEVELAND[1]

GROUPED ACCORDING TO THE ASSOCIATION SECTIONS

Section A (Mathematics). **American Mathematical Society. **Mathematical Association of America.

Section B (Physics). *American Physical Society. *American Meteorological Society.

Section C (Chemistry). Cleveland Section, American Chemical Society.

Section D (Astronomy). No other organizations.

Section E (Geology and Geography). No other organization.

Section F (Zoological Sciences). **American Society of Zoologists. **Entomological Society of America. **American Association of Economic Entomologists. ** American Society of Parasitologists. †Wilson Ornithological Club.

Section G (Botanical Sciences). **Botanical Society of America. **American Phytopathological Society. **American Society of Plant Physiologists.

Related to Sections F and G. **American Society of Naturalists. **Ecological Society of America. **American Microscopical Society. †Phi Sigma Biological Research Society. Genetics Sections, American Society of Zoologists and Botanical Society of America.

Section H (Anthropology). **American Anthropological Association. †American Folk-Lore Society. American Association of Physical Anthropologists.

Section I (Psychology). No other organizations.

Section K (Social and Economic Sciences). †American Statistical Association. †American Sociological Society. †American Economic Association. †Metric Association. American Political Science Association. American Farm Economic Association. American Association for Labor Legislation. American Association of University Instructors in Accounting. American Association of Teachers of Law in Collegiate Schools of Business. Stable Money Association.

Section L (Historical and Philological Sciences). **History of Science Society.

Section M (Engineering). No other organizations.

Section N (Medical Sciences). American Society of Tropical Medicine.

Section O (Agriculture). **American Society of Agronomy. *American Society for Horticultural Science. †Association of Official Seed Analysts of North America. †Potato Association of America. Geneticists Interested in Agriculture. Crop Protection Institute.

Section Q (Educational). No other organizations.

[1] Officially associated organizations that are affiliated with the American Association are designated by one or two asterisks (showing that they each have one or two representatives in the association council, respectively). Other officially associated organizations are each designated by a dagger.

Related to A. A. A. S. as a whole. **Society of the Sigma Xi. **American Association of University Professors. *American Nature-Study Society. †Gamma Alpha Graduate Scientific Fraternity. Sigma Delta Epsilon Graduate Women's Scientific Fraternity.

THE GENERAL PROGRAM

The General Program of the fourth Cleveland meeting is a book of 341 pages, containing the usual program material. Copies may be secured free by writing to the Washington office of the association.

The excellence of this important publication is due largely to Dr. Sam F. Trelease, program editor, and Mrs. Helen M. Trelease, who devoted themselves mainly to this work from about the middle of November and gave full time to it after December 13.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE PRESS SERVICE

(*By Austin H. Clark, director of the Press Service*)

The work of the Press Service at the Cleveland meeting was very greatly facilitated by the promptness with which those who were to give papers sent in their manuscripts, and especially by the way the papers were written and the abstracts prepared. For two weeks or more before the meeting the papers are studied by a number of representatives of the press in Washington, and a large proportion of the press accounts of the meeting are prepared at that time, being sent out from Washington to be released on the proper day. In this way far more attention can be devoted to the preparation of the press accounts than is possible during the week of the meeting, when everything must be done in more or less of a hurry; and furthermore it is possible to send the press accounts to papers all over the country by mail, thus saving telegraph charges. In addition to all this, the press representatives working in Washington on material submitted well in advance have within easy reach by telephone authorities on almost every subject, who are able to explain any points that may not be quite clear. This permits the use of many papers or abstracts that could not possibly be noticed during the rush of the meeting. It also insures greater accuracy and more satisfactory work generally on the part of the press representatives.

Perhaps it is not yet generally realized among those who take part in the scientific programs of these meetings that the press representatives do not attend sessions or listen to the reading of papers unless something more or less out of the ordinary is expected. They depend almost entirely upon the material sent to the Press Service in advance, and on interviews. Therefore if the manuscript of an address or contribution has not been available beforehand and is not

available in the press room at the meeting, that particular contribution does not exist so far as the press is concerned. It is manifestly impossible for the press representatives to hear any but a very small fraction of the many papers presented and a proper selection of the particular sessions to be attended is rendered very difficult by the fact that alluring titles sometimes are used in the program for papers of little news value, while far more frequently papers with very considerable news value appear in the program under highly technical and most formidable titles. So the press representatives, when they listen to papers at all, always select those of which they have some previous knowledge, through having seen copies or abstracts in the press room at the meeting or earlier in Washington.

It is very important that complete copies of all the addresses and papers to be delivered be sent to the director of the Press Service as long in advance as possible. An abstract alone is not sufficient, for the simple reason that its necessary brevity renders it too inflexible to serve as the basis of an adequate newspaper account. It is obvious that a newspaper article of two or three columns compiled from abstracts of papers in many different lines of science would make most uninspiring reading. Yet a skilful writer with the same abstracts accompanied by the complete papers can write a most fascinating story covering exactly the same ground—and the stories of no two writers working over the material would be alike. But abstracts are needed, to call attention to the main points brought out in the papers and to state these points clearly and concisely, so that any person with a moderate degree of intelligence and a reasonable education can understand.

In spite of their brevity—and because of it—good abstracts are much more difficult to write than good technical papers. In preparing an abstract of your paper a good idea is to imagine that you are anxious to make a deep impression on the fourteen-year-old son of some influential person who might aid your work. Or you might persuade some one with an ordinary high-school education, or perhaps less, and with no special knowledge of your subject, to listen to a recital of the main points in your paper and then tell you what impression you have made. Perhaps some point which you know to be quite insignificant may remain uppermost in the mind of your listener. If this be the case, that point, no matter how trivial it may appear to you, might well be the main theme of the abstract. Using that as an introduction you develop it in such a way as to work into the abstract what you know to be the really important part of your paper.

The reporting of the association's meetings would be greatly facilitated if each secretary of the sections and societies might get his program completed early enough to permit him to prepare or get prepared a general, non-technical account of the forthcoming sessions and if such accounts might be sent to the Press Service two or three weeks before the meeting. These accounts should point out present trends in the several lines of science as evidenced by the programs, calling attention to the outstanding and especially interesting papers. Excellent advance notices of this sort from the Phytopathological Society have shown the great value of such work. Advance accounts of the society programs would also greatly facilitate the preparation of the general reports of our meetings for publication in SCIENCE.

From the point of view of the Press Service the Cleveland meeting was the most successful we have held thus far. This was very largely due to the local committee on press relations, consisting of Mr. Charles F. Chapman, of the Case School of Applied Science (*chairman*); Miss Marie Kirkwood, of Western Reserve University, and Mr. Stanley Friedman, of the Brush Foundation. This committee arranged for extensive and most excellent advance press notice, and was constantly on hand during the entire week of the meeting. So efficiently was their work done that everything moved with unprecedented smoothness; at no time was there any of the confusion which has been experienced heretofore, especially on the first two days of a meeting. Mr. Watson Davis and the other members of the staff of Science Service gave the Press Service of the association the most cordial cooperation and rendered invaluable assistance, much of which was volunteered. There was nothing that they could possibly do which was left undone.

THE SCIENCE EXHIBITION

The Cleveland exhibition was housed in the gymnasium of Western Reserve University, where the registration offices were also located. It was the most successful exhibition yet held by the association. The commercial exhibits were again in charge of Colonel H. S. Kimberly, director of the exhibition. A special committee, of which Dr. F. C. Brown, of the Museum of Science and Industry, New York City, is chairman and Mr. Owen Cattell, of The Science Press, is secretary, arranged a fine display of research exhibits. These exhibits added very much to the value and attractiveness of the exhibition. Professor Henry B. Dates, of the Case School of Applied Science, was chairman of the local committee on exhibits. To him and his colleagues the association and the societies are greatly indebted.

Afternoon tea was served at the exhibition, as in previous years. An annotated list of the exhibits displayed at Cleveland is given in the general program, occupying seven pages. To the many exhibitors, who made the exhibition possible, the permanent secretary is glad to express the appreciative thanks of the association.

THE ASSOCIATION PRIZE

The eighth award of the American Association prize of $1,000 was made on January 3 to Messrs. M. A. Tuve, L. R. Hafstad and O. Dahl, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, for their paper entitled "Experiments with High-Voltage Tubes," presented before Section B (Physics) and the American Physical Society. This prize is awarded annually to the author of a noteworthy contribution to science presented at the annual meeting and shown in the general program.

The American Association for the Advancement of Science is able to make these annual prize awards through the generosity of a member who prefers to remain anonymous. A list of the names of those to whom the prize has been awarded is shown below, together with the topics dealt with in the winning papers.

(1) The Cincinnati award, January, 1924. L. E. Dickson, for contributions to the theory of numbers.

(2) The Washington award, January, 1925. Divided equally between Dr. Edwin P. Hubble, for contributions on spiral nebulae, and Dr. L. R. Cleveland, for contributions on the physiology of termites and their intestinal protozoa.

(3) The Kansas City award, January, 1926. Dr. Dayton C. Miller, for contributions on the ether-drift experiment.

(4) The Philadelphia award, January, 1927. Dr. George D. Birkhoff, for mathematical criticism of some physical theories.

(5) The Nashville award, January, 1928. H. J. Muller, for contributions on the influence of x-rays on genes and chromosomes.

(6) The New York award, January, 1929. Oliver Kamm, for contributions on the hormones of the pituitary gland.

(7) The Des Moines award, January, 1930. A. J. Dempster, for contributions on the reflection of protons from a calcite crystal.

(8) The Cleveland award, January, 1931. M. A. Tuve, L. R. Hafstad and O. Dahl, for contributions on the production of beta rays and gamma rays by means of high-voltage vacuum-tubes.

The permanent secretary is indebted to Mr. John A. Fleming, acting director of the Department of Research in Terrestrial Magnetism of the Carnegie Institution of Washington, for the following note on the prize paper.

The paper reported the artificial production of two of the three types of rays emitted by radium, namely, the beta-rays—very high-speed electrons—and the gamma-rays—very penetrating x-rays—by the application of potentials up to approximately 2,000,000 volts, produced by the familiarly known Tesla coil, to specially developed vacuum-tubes capable of withstanding this tremendous voltage. Measurements of the deflection of the beta-rays produced by the tubes in a calibrated magnetic field showed that the fastest beta-rays had speeds corresponding to the peak-voltages applied to the tubes, thus verifying the voltage-measurements. The gamma-rays from the tubes were measured through one, two and three inches of lead, and with the tube operated at a peak-voltage of 1,300,000 volts their penetrating-power or absorption-coefficient was found to be the same as that of the gamma-rays from radium measured under the same conditions.

The identity of the gamma-rays from the tubes with the rays used in the therapeutic applications of radium has aroused a considerable interest in the possible medical applications of high-voltage tubes. The equipment as at present used in the laboratory of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington produces the equivalent of a very large quantity of radium but only for an extremely short period of time, the operation of the tube being intermittent. Due to the limitations of small-sized electrical equipment and to the lack of necessity for large intensities of radiation for the physical measurements, as well as the personal risk to the experimenters themselves from heavy exposures to the rays, no particular effort has been made to increase the total intensity of the radiation. If large intensities of gamma-rays, comparable to very large amounts of radiation, are desirable for medical purposes, it is so far as can be foreseen chiefly a matter of the provision of the necessary equipment.

The present equipment at the laboratory of the Carnegie Institution, of small power but giving very high voltages, was developed for investigations related to atomic physics rather than to medicine. The general aim of the work looks toward investigations of the innermost structure of the atom, the atomic nucleus, probably along the lines of investigation initiated by Sir Ernest Rutherford and his colleagues using the rays emitted by radium and other radio-active substances. For this purpose it is thought especially important to extend the investigations to voltages well beyond the energy-equivalents of the natural rays from radium. Study of the atomic nucleus provides an opportunity for learning more nearly the true nature of the laws which underlie the whole material universe.

THE GENERAL SESSIONS

As in recent years, there were many general sessions at Cleveland. General sessions are planned to be sufficiently non-technical to interest men and women of science in all lines and usually the general public as well.

The opening session, Monday evening, December 29, was held in the Music Hall of the Public Audi-

torium. It was opened by Dr. Harry W. Mountcastle, general chairman of the Cleveland committee on arrangements. After brief addresses of welcome by Dr. Robert E. Vinson, president of Western Reserve University, Dr. William E. Wickenden, president of the Case School of Applied Science, and Mr. John D. Marshall, mayor of Cleveland, the chair was taken by President Thomas H. Morgan, who replied on behalf of the association and then introduced the main speaker of the evening, Retiring President Robert A. Millikan. Dr. Millikan's address was on "*Atomic Disintegration and Atomic Synthesis.*" It has appeared in SCIENCE for January 2, 1931.

The opening session was followed by the general reception, given by the local committee to the men and women of science and their friends. This occurred in the ballroom of the Public Auditorium. Both the opening session and the reception were unusually well attended.

On Tuesday afternoon, December 30, there were two general sessions. A session of the American Association's committee of one hundred on research and invited guests was devoted to discussions of the problems of the committee, concerning what may be termed the general environment of research workers in America. This program was in charge of Dr. Rodney H. True, of the University of Pennsylvania, secretary of the committee of one hundred. President Morgan presided.

The eighth annual Josiah Willard Gibbs lecture was presented on Tuesday afternoon, under the auspices of the American Mathematical Society. The lecturer was Dr. Edwin B. Wilson, of the Harvard University School of Public Health. He spoke on "Reminiscences of Gibbs by a Student and Colleague."

The general session on Tuesday evening was devoted to the ninth annual Sigma Xi lecture, given under the auspices of the Society of the Sigma Xi. The lecturer was Dr. C. E. K. Mees, of the Eastman Kodak Company, who spoke, with illustrations, on "The Science of Photography."

There were two general sessions on Wednesday afternoon. One of these was devoted to a program of nineteen invited papers on hydrobiology and aquiculture ("Water Farming"), arranged by Dr. James G. Needham, of Cornell University. The chairman for this session was Dr. E. A. Birge, of the University of Wisconsin. The papers ranged over a very broad field, from phytoplankton to fishes. They were mainly ecological in point of view and most of them dealt primarily with animals. At the other general session held on Wednesday afternoon Dr. Aleš Hrdlička gave a very interesting lecture on "Animal-like Manifestations of the Human Child."

The Wednesday evening general session was devoted to an illustrated lecture by Mr. Roger Lowell Putnam, trustee of the Lowell Observatory, Flagstaff, and Dr. V. M. Slipher, director of the Lowell Observatory. This was presented by Mr. Putnam. Its title was "Searching Out Pluto, Lowell's Trans-Neptunian Planet."

On Thursday afternoon Dr. W. H. Longley, of Goucher College, Baltimore, gave an illustrated non-technical lecture on "The Habits of Certain Fishes of the Dry Tortugas, Florida." He dealt largely with behavior reactions of the fishes inhabiting tropical reefs.

The general session on Thursday evening was devoted to an illustrated lecture on "Prehistoric Human Culture in the Southwestern United States," given by Dr. Frank H. H. Roberts, of the Bureau of American Ethnology, Smithsonian Institution.

The Cleveland series of general sessions was terminated on Friday evening, January 2, by an illustrated non-technical lecture on "Weighing the Earth," given by Dr. Paul R. Heyl, of the U. S. Bureau of Standards. The weight is actually about six thousand million million million tons, and Dr. Heyl showed how this has been ascertained.

BUSINESS PROCEEDINGS OF THE COUNCIL AND EXECUTIVE COMMITTEE AT CLEVELAND

The executive committee met on Monday morning, December 29, and the council met in the afternoon of the same day. The council held sessions on Tuesday, Wednesday and Thursday at 9 o'clock and the executive committee held a session immediately following each of these council sessions. The following items of business were transacted.

(1) The permanent secretary announced that Dr. Charles A. Shull had been appointed by the executive committee to fill the vacancy created by the resignation of Dr. Sam F. Trelease as secretary of the council.

(2) The minutes of the final council session at Des Moines were read and approved.

(3) The minutes of all Cleveland council sessions excepting the final one were read and approved.

(4) The permanent secretary announced that Mr. A. E. Twentyman had been named by the British Association for the Advancement of Science to represent it at this Cleveland meeting of the American Association, and that Mr. Twentyman had been invited to attend and take part in the Cleveland sessions of the council.

(5) The report of the treasurer and the financial report of the permanent secretary were accepted.

(6) The permanent secretary's notes on the financial condition of the association were accepted. (See another section of this issue of SCIENCE.)

(7) The permanent secretary presented a report on

membership up to December 19, 1930. (See another section of this issue of SCIENCE.)

(8) The permanent secretary's budget of prospective expenditures for the association year, 1930-31, was approved. The total amount is $107,510.

(9) On recommendation of the executive committee, the council elected to emeritus life membership the following named members: John Harvey Kellogg, who joined in 1875; Edward Bausch, who joined in 1877 and became a fellow in 1883; Simon H. Gage, who joined in 1879 and became a fellow in 1881.

(10) The council accepted the permanent secretary's report on fellowship nominations, secured from the section committees according to the new plan, for the calendar year 1930, and elected 1,313 fellows, distributed among the several sections as follows:

Section A, 15; Section B, 220; Section E, 232; Section F, 51; Section G, 212; Section H, 41; Section I, 56; Section K, 12; Section L, 34; Section M, 86; Section N, 105; Section O, 170; Section Q, 70.

(11) The executive committee invited the American Statistical Association to become officially affiliated with the American Association for the Advancement of Science. (This invitation has now been accepted.)

(12) The council accepted the resignations of Dr. Burton E. Livingston (permanent secretary) and Dr. Frank R. Lillie (general secretary).

(13) After considering an extended report from the executive committee and a special committee appointed by the executive committee the council unanimously elected Charles F. Roos, of Cornell University, as permanent secretary, to succeed Dr. Burton E. Livingston, at a salary of $6,000, beginning on February 1, 1931, or as soon thereafter as would be convenient to Dr. Roos.

(14) Dr. Burton E. Livingston was elected general secretary to succeed Dr. Frank R. Lillie.

(15) On recommendation of the executive committee, the council accepted with regret the resignation of Dr. R. H. True as secretary of the committee of one hundred on research, and expressed to Dr. True its very great appreciation of the valuable service he has rendered to American science through his effective work in guiding the activities of the committee of one hundred since its reorganization five years ago.

(16) On recommendation of the executive committee, the council voted that the naming of a successor to Dr. True be referred to the executive committee of the association with power.

(17) On recommendation of the executive committee, the council voted that Dr. W. A. Noyes be named a member of the executive committee of the committee of one hundred, and that the executive committee of the committee of one hundred be authorized to fill other vacancies, and to reorganize the subcommittees of the committee of one hundred wherever such action is needed.

(18) On recommendation of the executive committee the council voted that Dr. F. C. Brown and Mr. Owen Cattell be asked to continue as chairman and secretary, respectively, of the committee on research exhibits, and that they complete the committee and proceed to arrange for research exhibits at the New Orleans meeting.

(19) Acting on special authorization by the council the executive committee voted to continue the present arrangement with Colonel H. S. Kimberly, as manager of the annual exhibition, for one year, and Colonel Kimberly was asked to proceed to arrange for commercial exhibits for the New Orleans exhibition and to cooperate with Dr. Brown, Mr. Owen Cattell and the committee on research exhibits, to the end that both the commercial and research aspects of the association's exhibition at New Orleans might be as useful and satisfactory as possible. The arrangement with Colonel Kimberly is as follows: He arranges for the commercial part of the exhibition and receives all net profits up to $2,500; when profits exceed that amount they are equally divided between him and the association; each year the association advances funds to Colonel Kimberly, if necessary, up to $500, this advance to be refunded out of the income from the exhibition and charged to expense.

(20) The executive committee voted that the salary of the executive assistant, Mr. Sam Woodley, should be $4,500 per annum, beginning with January 1, 1931, and expressed its great appreciation of Mr. Woodley's loyal and efficient service to the association.

(21) The council accepted a progress report of the committee on source books in the sciences; chairman, Dr. Gregory D. Walcott.

(22) The executive committee accepted a report on *Biological Abstracts*, received from Dr. Herbert Osborn, representative of the association on the board of *Biological Abstracts*.

(23) On recommendation of the executive committee the council voted that a comprehensive survey of American colleges and universities with respect to scientific research, as recommended by the committee of one hundred, be authorized under the auspices of the committee of one hundred, with the general direction of the executive committee of the association.

(24) On recommendation of the executive committee, acting at the suggestion of the committee on grants for research, the council voted that the committee of one hundred's subcommittee on scientific publications be asked to make, with the cooperation of the committee on grants, a study of publication problems in relation to the best use of association funds, and that there be appropriated from the treasurer's available funds the sum of $500 (or such part of that sum as may be needed) for use by the subcommittee in this connection.

(25) On recommendation of the executive committee of the council, acting upon a recommendation from the committee on grants for research, the council voted that the committee on grants be asked to secure from the fellows of the association, by means of a circular letter of inquiry sent out from the Washington office, suggestions as to what particular aspects and fields of research might be specially considered by the committee on grants in its study of ways by which association funds might be used to further scientific research.

(26) On recommendation of the executive committee, the council voted to cooperate fully with Dr. Henry Crew and the other officers of the Chicago World's Fair Centennial Celebration in regard to foreign men of

science who are to be invited to give addresses at the scientific sessions to be held in connection with the World's Fair in the summer of 1933.

(27) The council voted that a committee be named by the president, in consultation with the executive committee, to represent the association in this cooperation.

(28) On recommendation of the executive committee, acting upon a special request received from Mr. Wm. John Cooper, commissioner of education, U. S. Department of the Interior, the council voted that a representative of the American Association be appointed to be a member of the professional advisory committee of the National Survey of the Education of Teachers, which has been authorized by Congress and is being carried out by the Office of Education of the Department of the Interior. The council voted that Dr. J. McK. Cattell, chairman of the executive committee and past president of the association, be named as this representative.

(29) At its Thursday session the council unanimously elected Dr. Franz Boas president of the American Association for the Advancement of Science for 1931.

(30) On nominations from the several sections the council elected fifteen vice-presidents for 1931, as follows: A, Earl R. Hedrick; B, Bergen Davis; C, Charles A. Browne; D, J. H. Moore; E, Douglas Johnson; F, R. W. Hegner; G, E. D. Merrill; H, W. K. Gregory; I, H. S. Langfeld; K, G. C. Evans; L, W. B. Munro; M, Dexter S. Kimball; N, Howard T. Karsner; O, C. G. Williams; Q, Ernest Horn.

(31) F. G. Cottrell (chemistry) and A. F. Woods (agriculture) were elected to the council (to succeed David White and L. E. Dickson), and J. McK. Cattell and Henry B. Ward were elected to the executive committee (to succeed themselves); the terms of these officers are to expire at the end of December, 1934.

(32) Herbert Gill was reelected to the finance committee, his term of office to expire at the end of December, 1934.

(33) J. McK. Cattell was nominated as a representative of the association on the board of trustees of Science Service, for a term expiring in April, 1934.

(34) On recommendation by the executive committee the council approved modifications of the rules for the prize award as follows: Presidential and vice-presidential addresses and invitation papers of the type of such addresses shall not be eligible for consideration by the award committee. The committee on award is to make its decision before leaving the meeting place, and public announcement of the award is to be made through the Association Press Service as promptly as possible, but not before the meeting has actually closed. The committee on award is to devote sufficient time to this decision, remaining a day or two after the close of the annual meeting. Each member of the award committee who thus stays over is to receive, in lieu of expenses, an allowance of \$50. The subject of the prize paper for a meeting is to be specially presented at the next following summer meeting of the association if that is feasible, otherwise at the next following winter meeting.

(35) Besides the \$500 noted in paragraph 24, above, the council voted the following appropriations from the treasurer's available funds: \$300 for three emeritus life memberships, \$3,000 for allotment by the committee on grants for research, \$1,000 for expenses of the committee of one hundred on research.

(36) On recommendation of the executive committee the council voted that the meeting of December, 1932, be held at Atlantic City if suitable arrangements can be made.

(37) On recommendation of the executive committee the council voted that the summer meeting of 1932 be held at New Haven, if suitable arrangements can be made.

(38) The council voted that the executive committee and the council should hold business sessions at the summer meetings.

(39) It was voted that any section which finds it not feasible to organize a program for a summer meeting may omit its summer program.

(40) The executive committee voted that the sum of \$500, or such portion thereof as might be necessary, be appropriated from the permanent secretary's funds for use in connection with arrangements for public lectures at the approaching Pasadena meeting.

(41) It was voted that the executive committee favors having a registration fee at the Pasadena meeting, also that it favors having some restriction with regard to admission to the public lectures at that meeting, so as to give some advantage to members and associates.

(42) The executive committee voted that advertising in the Pasadena program shall be arranged by the Washington office, with the cooperation of the local committee for the meeting.

(43) The executive committee voted that all associate fees collected for the Pasadena meeting and an amount equal to 25 per cent. of all life membership fees and all sustaining membership fees collected through the efforts of the Pasadena committee shall be available to the committee for financing the meeting.

(44) In response to a request from Mr. J. Franklin Meyer, it was voted by the executive committee that Dr. A. E. Kennelly and one other to be selected by him be nominated as representatives of the association in the Group of Advisers on Symbols, which is being organized by the U. S. National Committee of the International Electrotechnical Commission.

(45) It was voted that the regular spring meeting of the executive committee would be held in Washington on Sunday, April 26, 1931.

(46) Five general resolutions were each unanimously adopted by the council, as set forth in the following section of these reports.

THE FINANCIAL CONDITION OF THE ASSOCIATION

The permanent secretary presents the following notes on the finances of the association, based on the treasurer's report and the permanent secretary's financial report, which were accepted by the council at Cleveland, and on minutes of the executive committee (November 30, 1930) and of the council at Cleveland.

THE TREASURER'S FUNDS

On September 30 the treasurer's principal funds were as follows:

General endowment (income for research, etc.)		
By gifts and bequests	$103,526.66	
Fees of deceased sustaining members (3) and life members (217)	14,800.00	$118,326.66
Jane M. Smith fund (income for emeritus life memberships		5,000.00
Fees of living sustaining members (4) and life members (470) (income for any purpose)		38,900.00
Prize fund ($1,000 of principal available for prize, income for any purpose)		5,000.00
Treasurer's reserve (principal and income available for research, etc.)		9,071.31
Total		$176,297.97

The total interest received in 1929–30 was $7,416.35, the average interest rate being 4.207 per cent. Appropriations for 1930–31 and the funds from which they are derived are shown below.

	Research fund	Emeritus fund	General fund
Journal subscriptions for sustaining and life members			$1,422.00
Safe-deposit box			20.00
Expenses of grants committee, Cleveland session			126.16
Expenses of prize award committee			250.00
Three emeritus life memberships		$210.35	89.65
Allotted by committee on grants, for 1931	$3,000.00		
Expenses, committee of one hundred on research	1,000.00		
Investigation of problem of publications	500.00		
Total	$4,500.00	$210.35	$1,907.81
Amount available	4,978.00	210.35	2,228.00
Unassigned balance	$ 478.00	$	$ 320.19

Further appropriations for the current year might amount to $478.00 from research funds and $320.19 from general funds. It will be recalled that appropriations for emeritus life memberships go into the treasurer's principal funds, the income therefrom being available for any purpose until the decease of the members, after which the income becomes available only for research or similar purposes.

THE PERMANENT SECRETARY'S FUNDS

The permanent secretary's financial report of September 30, 1930, shows the following appropriable funds, some of which are, however, designated for specified purposes:

Special funds:		
Committee on Research in Colleges	$ 34.47	
Committee on Place of Science in Education	4,645.55	
Committee on Science Reading Lists	4,014.16	
		$8,694.18
Permanent secretary's emergency fund (for general purposes)		5,000.00
Publication fund (for Proceedings)		4,280.88
Meeting fund (for expenses of meetings)		3,895.00
Accumulation (for general purposes)		10,930.41
Total		$32,800.47

Appropriations from the permanent secretary's funds for this year (1930–31) will presumably be covered by the current income. It is reasonable to suppose that the total cost of operation of the permanent secretary's office for the current year may exceed the permanent secretary's proposed budget ($107,510) by as much as $3,662 without disturbing any of the funds accumulated from past years.

RESEARCH GRANTS FOR 1931

An appropriation of $3,000 from the treasurer's available funds was made by the council at Cleveland and this sum was allotted to applicants by the committee on grants for research, as follows:

Chemistry

W. H. Cole, Rutgers University, New Brunswick, N. J. For quantitative studies on chemical stimulation in animals $200

Astronomy

Margaret Harwood, Maria Mitchell Observatory, Nantucket, Mass. For continuation of studies of the size and distance of the Scutum Star Cloud through an investigation of the variable stars 300

Harlan T. Stetson, Ohio Wesleyan University, Delaware, Ohio. For research in correlation of solar radiation with ionization of the terrestrial atmosphere as determined by quantitative measurements of radio reception 400

Geology and Paleontology

Edwin T. Hodge, University of Oregon, Eugene, Oregon. For a geologic investigation directed to a comparative study of certain differences between Washington and Oregon workers 100

Biophysics

Harry Clark, Stanford University, Calif. For study of physical and biological effects of x-rays. (The particular problem for the pres-

ent is the statistical study of the lethal effect of very intense soft radiation of the organism *euplotes*) 123

Leslie A. Chambers and Newton Gaines, Texas Christian University, Fort Worth, Texas. For study of physical and biological effects of audio-frequency sound of great intensity 300

Zoology

W. W. Cort, Johns Hopkins University, Baltimore, Md. For studies on life cycles of digenetic trematodes 250

Henry Federighi, Antioch College, Yellow Springs, Ohio. For studying the reactions of the duomatophores in newly transplanted skin 50

Ann Morgan, Mount Holyoke College, South Hadley, Mass. For study on respiration and winter conditions of aquatic insects 400

Botany

W. A. Cannon, Stanford University, Calif. For continuation and extension of studies on translocation of oxygen in land plants 300

Geo. Hume Smith, 1925 Central Ave., Indianapolis, Ind. For purchase of a camera for studies on the formation and the development of the leaf buds of some of our common trees 27

Paul Weatherwax, 416 S. Dunn St., Bloomington, Ind. For studying the ancestry and relationships of the Indian corn plant 200

Physiology

Helen C. Coombs, New York Homeopathic Medical College, New York, N. Y. For continuation of studies on the nervous control of respiration 50

R. W. Gerard, University of Chicago, Chicago, Ill. For construction of apparatus for the recording of nerve action 300

OFFICERS ELECTED

The officers elected by the council at Cleveland have been named in the section on business proceedings and their names and addresses have been published in SCIENCE for January 9, 1931, pages 34 and 35. In addition to these, the section secretaries have reported the following elections, by the respective sections, of members of the corresponding section committees. Unless otherwise shown, the terms of office of all these committeemen are to expire at the end of 1934.

Section A (Mathematics), E. B. Stouffer, University of Kansas (to succeed R. D. Carmichael).

Section B (Physics), Raymond Thayer Birge, University of California (to succeed Leigh Page).

Section C (Chemistry), Frank C. Whitmore, Pennsylvania State College (to succeed Samuel Colville Lind).

Section D (Astronomy), Annie J. Cannon, Harvard Observatory (to succeed Harlan True Stetson).

Section E (Geology and Geography), Edward W. Berry, Johns Hopkins University (to succeed Florence Bascom).

Section F (Zoological Sciences), William B. Herms, University of California (to succeed Raymond C. Osburn).

Section G (Botanical Sciences), Henry Reist Kraybill, Purdue University (to succeed Charles O. Appleman).

Section H (Anthropology), Adolph H. Schultz, Johns Hopkins Medical School (to succeed William K. Gregory).

Section I (Psychology), Walter R. Miles, Yale University (to succeed Joseph Peterson).

Section K (Social and Economic Sciences), Henry Schultz, University of Chicago (to succeed himself).

Section L (Historical and Philological Sciences), G. M. Bolling, Ohio State University (to retire at end of 1934, succeeding Edwin W. Schreiber); L. C. Karpinski, University of Michigan (to retire at end of 1933); W. A. Oldfather, University of Illinois (to retire at end of 1932); E. Sapir, University of Chicago (to retire at end of 1931).

Section M (Engineering), William E. Wickenden, Case School of Applied Science (to succeed John Lyle Harrington).

Section N (Medical Sciences), Anton J. Carlson, University of Chicago (to succeed Joseph Leidy).

Section O (Agriculture), Joseph H. Gourley, Ohio Agricultural Experiment Station (to succeed H. J. Wheeler).

Section Q (Education), Truman Lee Kelley, Harvard University (to succeed Otis W. Caldwell).

THE PRESIDENT ELECT

(*By J. R. Swanton, Bureau of American Ethnology, Smithsonian Institution*)

Professor Franz Boas, the new president of the American Association for the Advancement of Science, was born at Minden, Germany, and attended the universities of Heidelberg, Bonn and Kiel, where he specialized in the natural sciences. He received the degree of Ph.D. from the last-mentioned institution in 1881, his first contributions to science being in the department of physics. In 1883 he was sent to Baffin Island to take charge of a German meteorological station, and there his contact with the Eskimo turned his interests definitely to anthropology. In 1885 he returned to Berlin as privatdocent in the university and assistant in the Royal Ethnographical Museum. A year later, however, he left for the North Pacific coast of our continent, destined to be the scene of much of his future work, and after a short period spent in New York on the editorial staff of SCIENCE, he returned to that field in the interests of a "Committee Appointed by the British Association for the Advancement of Science to Investigate the Northwestern Tribes of Canada," and undertook a number of field expeditions under its auspices until it closed its work in 1897. Meantime, in 1889, he was called to Clark University, then just established, as docent in anthropology, but left in 1892 to become first assistant in the anthropological department of the

World's Columbian Exposition at Chicago. This service he continued until 1894, long enough to organize the anthropological section of the Field-Columbian Museum (now the Field Museum of Natural History), an outgrowth of the great fair. In 1895 he was appointed assistant curator of anthropology in the American Museum of Natural History, New York, and from 1900 to 1905 he was full curator, during a time notable for the activities of the Jesup North Pacific Expedition, of which he was the director and the leading spirit. This expedition brought out the first specific, scientific proof of cultural relationship between peoples of Siberia other than the Eskimo and our own Indians.

In 1896 Professor Boas was appointed lecturer in anthropology in Columbia University, and in 1899 full professor, a position which he still holds. During the period of his incumbency, anthropology has experienced a very rapid growth in all its widely ramifying branches, and he has exerted a powerful influence upon the entire range of them. Aside from his own contributions to the science, he has found means and opportunity to further the work of many others, some his own pupils and some independent workers or men strategically placed to secure valuable scientific information. He took up the editorship of the *Journal of American Folk-Lore* in succession to Newell and Chamberlain, conducted it directly for many years, and is still an associate editor. He also edits, or has edited, the Columbia University Contributions to Ethnology, the Publications of the American Ethnological Society, the Handbook of American Indian Languages (Bull. 40 of the Bureau of American Ethnology), the *International Journal of American Linguistics*, the Memoirs of the Jesup North Pacific Expedition, and the bulletins of the American Museum of Natural History on anthropology during his connection with that institution. He has received honorary degrees from Clark University, from Oxford and from Graz, is an honorary or corresponding member of the principal learned societies of this country and Europe, and has presided over or occupied official positions in practically all those in America connected with his special field.

There is scarcely a branch of anthropology to which Professor Boas has not made some noteworthy contribution, and several of his papers now rank as classics. Besides his services to folklore as editor of its official organ, his name is particularly linked with a monumental publication on "Tsimshian Mythology" (in the Thirty-second Annual Report of the Bureau of American Ethnology), in which comparative studies of one relatively small group of Indians have been so extended that the work assumes the proportions of a concordance of American myths. The "Ethnology of the Kwakiutl," in the same series—which bears his name along with that of a native informant, George Hunt—exhibits a model method of extracting ethnological data through the medium of native texts. Much of the discussion of totemism and the organization of primitive society has been carried on by his pupils, but his own work on the tribes of the North Pacific coast, notably the Kwakiutl, has played a great part in it. His study of the secret societies of the Kwakiutl (in the Report of the U. S. National Museum for 1895) was the first intimation many anthropologists had of the importance of this subject. On primitive art may be mentioned "The Decorative Art of the Indians of the North Pacific Coast" (Bull. IX, American Museum of Natural History, 1897), and "Primitive Art" (Oslo and Cambridge, 1927), while his treatment of "Religion" in the Handbook of American Indians (Bull. 30, Pt. 2, Bureau of American Ethnology), is probably the best short statement of the exceedingly difficult subject of Indian belief. On specific areas, his contributions to the ethnology of the Eskimo and the Indians of the North Pacific coast are the most numerous and the most noteworthy. The larger part of these concern peoples on the northern side of the international boundary, and, as a further service to Canadian anthropology, may be mentioned his papers in the Annual Archeological Report for 1905, published as an appendix to the Report of the Minister of Education, Ontario. Professor Boas is the author of papers on Indian languages spoken in several different parts of America, including practically all those on the North Pacific coast, his most important communications being on Tsimshian, Kutenai, Kwakiutl and the Salish dialects. His latest service to the study of American Indian tongues has been exerted as chairman of a committee of the American Council of Learned Societies having to do with "Research in the Native American Indian Languages," which, thanks to a liberal grant from the Council, has already rescued a vast amount of linguistic material threatened with disintegration or in danger of total loss and furnished extensive data for detailed grammatical study and comparative use.

Professor Boas's activities in physical anthropology constitute a chapter in themselves and they have not been confined to the American aborigines. As far back as 1891 he published papers on the growth of school children and his interest in the subject has continued to the present time. But his most important work in this field, certainly that which has excited the most general interest, was initiated in 1908 when he began, under instructions from the U. S.

Immigration Commission, an investigation of the physical characters of immigrants. This indicated that certain physical characters may change in one generation in response to change in environment, a fact which of course has an important bearing upon the whole racial problem, and may make necessary a reorientation of the subject.

Loath as Professor Boas is to generalize extensively, so many studies on the bodies and minds of various peoples and racial types could hardly fail to awaken in him certain personal reactions toward cultural and human values, and it is fortunate that he has not refrained from giving expression to some of these. On the great problem of independent origination versus diffusion, which has dogged and plagued cultural anthropologists at all periods, we find him taking a carefully weighted middle ground, in vigorous opposition to extremists. Although wording his conclusions cautiously, he gives little support to upholders of any doctrine of racial superiority, and his "Mind of Primitive Man," printed in 1911 but based upon his address as retiring president of the American Folk-Lore Society in 1900, is sometimes regarded as a Magna Charta of self-respect for the "lower" races. The same spirit prevails in his "Kultur und Rasse" (1913) and in his much more recent volume, "Anthropology and Modern Life" (1928), intended for a wider audience.

The stimulus which Professor Boas has contributed to anthropology in America has borne fruit in the opening in our universities of an ever-increasing number of departments devoted to that science, staffed largely by his pupils and former associates. It is fortunate that such extensive influence is wielded by one who, besides being a tireless accumulator and precise recorder of data, is meticulously careful in weighing results and rigidly conservative in announcing conclusions.

THE CLEVELAND SESSION OF THE SECRETARIES' CONFERENCE

(*Report from N. H. Heck*)

The Cleveland session of the Secretaries' Conference and the secretaries' complimentary dinner were held on Thursday evening, with Harley J. Van Cleave in the chair. One of the topics discussed was the cooperation of the secretaries with the association's committee on the selection of foreign scientists who are to be invited to take part in the scientific meetings at Chicago in the summer of 1933. The problems of the sections with which societies do not hold meetings and of those with which so many hold meetings that there is congestion were given consideration. Several plans for possible improvements were suggested. Methods of securing new members of societies and of clearing the society lists formed another subject of discussion. Dr. Livingston described the working of the fellowship nomination plan adopted last year. The secretary of the Secretaries' Conference for 1931 is N. H. Heck, secretary of Section M. The chairman for 1931 is Harley J. Van Cleave, secretary of the American Microscopical Society.

THE CLEVELAND SESSION OF THE ACADEMY CONFERENCE

(*Report from S. W. Bilsing*)

The Academy Conference is a standing committee of the American Association, consisting of the 24 council representatives of the affiliated academies, one from each academy, and three members representing the association as a whole. It facilitates cooperation between the academies and the association as well as among the academies themselves. The Cleveland session of this conference was held on Monday afternoon, following the first Cleveland session of the association council. The conference secretary for 1930, Chancey Juday, of the Wisconsin Academy, automatically became chairman for this session and for the year 1931. S. W. Bilsing, of the Texas Academy, was elected secretary for 1931. Eighteen of the academy representatives were present, and all three representatives of the association at large, also several invited guests. Dr. E. C. L. Miller, of the Virginia Academy, presented a review of the methods and procedures followed by the several academies in developing their libraries. Dr. John T. McGill, of the Tennessee Academy, discussed science clubs in relation to the state academies, describing especially the relations that have been developed in Tennessee. Miss S. Aleta McEvoy presented, by invitation, a paper on the Illinois Junior Academy of Science, a young and very vigorous organization with branches in the high schools. It provides a means by which youthful beginners in science may develop their interests and capacities in the direction of original studies and investigations. It encourages and stimulates high-school students who have interest in science. As recently developed in Illinois, this plan has great possibilities. The conference session closed with the annual Academy dinner, given by the American Association to the members of the conference. A unanimous vote of appreciation was extended to Dr. Livingston, and through him to the American Association, for the vigorous development of the Academy Conference and for the courtesy of this Cleveland dinner.

FUTURE MEETINGS OF THE ASSOCIATION

The American Association meets annually in convocation week, at the time of the Christmas holidays, the dates of these winter meetings being determined

by the following rule. When New Year's day falls on Thursday, Friday or Saturday, the meeting period is the week (Monday to Saturday, inclusive) in which New Year's day occurs. When New Year's day falls on Sunday, the meeting period is the preceding week. And when New Year's day falls on Monday, Tuesday or Wednesday, the meeting opens on December 27 and continues through January 2.

The dates and places for several future winter meetings are shown below.

Meeting of 1931–32, New Orleans; Monday, December 28, 1931, to Saturday, January 2, 1932.

Meeting of 1932–33, probably Atlantic City; Monday, December 26, to Saturday, December 31, 1932.

Meeting of 1933–34, undecided; Wednesday, December 27, 1933, to Tuesday, January 2, 1934.

Meeting of 1934–35, probably Rochester; Thursday, December 27, 1934, to Wednesday, January 2, 1935.

The association meets regularly in a four-year rotation, at New York, Chicago and Washington. The last quadrennial meeting was held in New York, opening in December, 1928, and the meeting opening in December, 1932, would regularly occur in Chicago; but the council has voted to hold a summer meeting in Chicago in 1933, at the time of the World's Fair. The Atlantic City meeting will consequently be the quadrennial one with respect to the election of officers.

It has recently been decided to hold two meetings each year, a summer meeting in addition to the regular winter meeting. The first summer meeting on this new plan is to be held at Pasadena late in June, 1931. The exact dates are not yet surely fixed. The summer meeting of 1932 will probably be held at New Haven. As just mentioned, there is to be a summer meeting at Chicago in 1933. The summer meeting of 1934 will probably be held at San Francisco.

THE SCIENTIFIC SESSIONS AT CLEVELAND

The following accounts of the sessions of the sections and societies that met simultaneously with the American Association this year have been prepared by the permanent secretary from reports furnished by the several section and society secretaries, as indicated. They are arranged according to the association sections. Several societies are shown as related to both the zoological and botanical sections and another group is related to all sections. Reports were requested from the secretaries of all organizations shown in the General Program of the Cleveland meeting and almost all of them responded.

SECTION A (MATHEMATICS) AND RELATED ORGANIZATIONS

(*Report from C. N. Moore and W. D. Cairns*)

On Monday afternoon there was a joint session of Sections A and K, the American Statistical Association and the American Mathematical Society, at which time a series of interesting papers on various mathematical features of economic and statistical theory was presented by G. C. Evans, Ragnar Frisch and Harold Hotelling. On Wednesday morning Section A and Section D joined with Section L and the History of Science Society in a session in commemoration of the tercentenary of the death of Kepler. At this session papers dealing with various phases of the life and work of Kepler were presented by D. J. Struik, W. C. Rufus and E. H. Johnson. On Wednesday afternoon Section A held a joint session with the American Mathematical Society and the Mathematical Association of America. E. T. Bell gave the retiring vice-presidential address on "Mathematics and Speculation," which will be published in *The Scientific Monthly*. This paper was followed by invitation addresses by Oystein Ore and Karl Menger. Professor Ore's lecture dealt with the fundamental concepts of algebra and equation theory, and more particularly with the present point of view on the solution of equations by means of the method of Galois. Professor Menger gave an account of recent work by himself and others on constructing a theory of dimension from the axiomatical standpoint.

On Tuesday afternoon G. D. Birkhoff gave an address at the invitation of the American Mathematical Society. Professor Birkhoff's lecture was devoted primarily to an account of some of his recent work on generalizations of Poincaré's last geometric theorem and applications of these results to certain important dynamical problems. The theorem in question is the one stated by Poincaré in one of his last published papers with the remark that he had not succeeded in proving it and wished to submit it to the consideration of other mathematicians. It was proved shortly after this by Professor Birkhoff in an article which appeared in the Transactions of the American Mathematical Society in 1913. Recently Professor Birkhoff has been engaged in the study of generalizations of Poincaré's theorem to higher dimensions together with their dynamical applications, and he has been invited to present the results of these investigations in a series of lectures at the Collège de France in April of the present year. His address at Cleveland gave the mathematicians present an opportunity to acquaint themselves with the scope of these important studies.

Subsequent to Dr. Birkhoff's lecture, Professor E. B. Wilson delivered the eighth Josiah Willard Gibbs lecture on the subject, "Reminiscences of Gibbs by a Student and Colleague." As the title indicates, Professor Wilson's address dealt with the life and personality of Gibbs rather than with his technical scientific work. He painted an appealing picture of a great scientist quietly pursuing his life work without

pomp or ostentation. Among other interesting side-lights, Professor Wilson pointed out that, just as in the case of other great figures of history, many of the traditions concerning Gibbs were totally unfounded in fact.

On Tuesday morning and Wednesday morning the American Mathematical Society held six separate sectional meetings for the presentation of contributed papers. Immediately prior to the scientific sessions of Wednesday morning there was held a business session for the election of officers.

The Mathematical Association of America held two sessions on Thursday in addition to the joint meeting on Wednesday afternoon with Section A and the American Mathematical Society. Benjamin F. Finkel, of Drury College, put on record for the Mathematical Association the early history of the *American Mathematical Monthly,* which he founded at Kidder, Missouri, in 1894 and edited, largely by his own efforts, until it was assumed by a large group of American colleges and universities in 1913, and transferred formally to the Mathematical Association of America on its organization in December, 1915. J. W. Alexander, of Princeton University, presented a paper on analysis situs as a branch of elementary geometry with an indication of various problems that are as yet unsolved. J. R. Musselman, of Western Reserve University, gave a treatment of the equilateral hyperbola along lines analogous to the more familiar development of theorems connected with the circle. Tibor Radó, of Ohio State University, described the character of competition for the Eötvös prize in Hungary, a competition which calls for no mathematics beyond early collegiate courses but which requires the student to exhibit qualities that will probably lead to later creative effort. J. F. Reilly, of the University of Iowa, gave a summary of various formulas for the remainder terms used in interpolation and gave also illustrations of the accuracy of these formulas in computing logarithms. C. F. Roos, of Cornell University, gave an ordered account of the more recent mathematical formulations expressing the interrelations of demand, cost of production and profit; he showed by concrete examples what may be accomplished in fitting mathematical functions to actual commodity curves over a number of years.

SECTION B (PHYSICS) AND RELATED ORGANIZATIONS

(*Reports from A. L. Hughes and G. H. Noyes*)

Section B met with its affiliated societies, the American Physical Society and the American Meteorological Society. C. E. Mendenhall, the retiring vice-president of the section, gave an address on "Recent Developments in Photoelectricity." This was a discussion of recent experimental results and their relations to the corresponding developments in the application of the new statistics and wave-mechanics to the theory of metals. Special consideration was given to the selective effect and to some new unpublished studies of photoelectric phenomena at high temperatures, which show a systematic shift of the threshold towards the red with increasing temperature. Particular attention was paid to the photoelectric characteristics of thin films which have been investigated recently by several physicists. Though the results in this field are extremely interesting, they raise more questions than they answer. Professor Mendenhall's address was printed in full in SCIENCE for January 31. The address of the retiring vice-president was followed by a symposium on "Acoustics." The selection of acoustics as a topic was particularly appropriate in that the meeting was held in the laboratory of Professor D. C. Miller, whose leadership in acoustical research is acknowledged by all. Dr. Paul E. Sabine spoke on "Recent Developments in Architectural Acoustics." He enumerated the conditions which are requisite for "good hearing" in any auditorium, and briefly discussed the various factors involved. As the reverberation in a room is the most important single characteristic from the standpoint of architectural acoustics, the reverberation equation, which has been derived theoretically and verified experimentally, was discussed in detail. Prolonged reverberation must be avoided, but it is undesirable to avoid reverberation altogether, particularly when music is concerned. The most suitable reverberation time appears to be about 1.4 seconds. Our knowledge of architectural acoustics has now been developed to the point where it is possible to predict precisely the acoustical characteristics of a room when the materials of which it is made are known. There is therefore no longer any excuse for constructing an auditorium in which the hearing is unsatisfactory. Dr. Harvey Fletcher, of the Bell Telephone Laboratories, contributed a paper on "Some Physical Principles of Speech and Music." Oscillograph records of typical spoken English sentences showed how speech consists of a series of fundamental sounds called continuants, which are connected together by transitional elements. The continuants consist of several complete wave cycles which are almost alike, while the transitional elements consist of a continuously changing wave from cycle to cycle and sometimes of a complete stop. A series of pitch changes of these continuants constitute the main melodic stream of speech. There are two other minor melodic streams corresponding to the characteristic resonant pitches of the mouth and throat cavities when shaped for producing the various vowel sounds. Using these conceptions, the difference between speaking and singing was

pointed out. The speech power of different speakers and of different fundamental sounds spoken by a typical speaker were discussed. From peak power measurements upon typical speech, an audibility curve was constructed which showed the range in frequency and intensity of audible speech. Then followed a similar discussion of musical sounds, using oscillograms, peak and average powers of typical musical instruments, both individually and also when grouped into an orchestra. The third paper in the symposium was contributed by Dr. C. W. Hewlett, of the Research Laboratory of the General Electric Company. The title of this paper was "Concerning Some of the Problems Encountered in Recording and Producing Photographic Sound Records on Motion Picture Film." The paper began with a concise account of the train of steps between the impact of the sound waves on the microphone and their permanent registration on a moving film negative in the recording half of the process, and between the positive of this permanent record and the loud speaker in the reproducing part of the process. Appreciable distortion must be avoided at every stage in the process. The details of how distortion has been greatly diminished were fully discussed.

The attendance at the meetings of the section and its associated societies was large; it is to be recorded that 350 persons were present at the joint meeting of Section B and the American Physical Society. The regular program of the Physical Society contained about eighty-five contributed papers. At the annual meeting of the Physical Society the following officers were elected for the coming year: *President*, W. F. G. Swann; *vice-president*, P. D. Foote; *treasurer*, G. B. Pegram; *secretary*, W. L. Severinghaus.

The twelfth annual meeting of the American Meteorological Society opened on Monday morning, December 29, with President John Patterson, director of the Meteorological Office of Canada, presiding. In the two-day meeting there were three sessions and a field trip. A wide variety of papers were presented, ranging from personal experiences in taking weather observations in Greenland and Antarctica, weather with relation to air and lake navigation, education in meteorology, to meteorological history and discrepant nomenclature. The drought of 1930, which so greatly affected vast numbers of people, was a topic of keen moment. Students of meteorology not on the U. S. Weather Bureau staff provided topics for thought and lively discussion. Dr. Hobbs and Mr. Schneider conveyed the interest of the meeting to Greenland, and Mr. Harrison kept his audience in profound attention through Antarctic cold and winter darkness. Mr. Ward T. Van Orman, one of the most widely known balloonists, outlined the various steps involved in finding the optimum location for an airship transatlantic terminus on the eastern seaboard, and Mr. Patterson's presidential address revealed the minute plans in operation during the great flight of the British dirigible from England to Ontario. Mr. George A. Marr gave a highly pertinent address upon the subject of weather and Great Lakes navigation from the point of view of the public, through the agency of the shippers, shipmasters and shipowners. The shipmaster and the air pilot have to navigate their crafts through the weather and waters whereof the forecaster has advised them. A visit was made to the Cleveland Airport Weather Bureau station. Mr. C. G. Andrus described much of the detail of collecting weather reports along the airways, deducing flying conditions and getting these reports into the hands of flight operators. While the party was assembled, the flight officers of a large passenger transport plane cancelled a flight because of impending bad weather, and a few minutes later came advices that the airport to which the flight was planned had become closed in by snowstorms. Mr. V. E. Jakl, who came to this meeting by plane from Omaha, read a paper on fog and low clouds in relation to aviation, and Mr. Ralph Upson discussed the development of airplanes, showing interrelations of designer, pilot, weather and weather forecaster. Dr. Dinsmore Alter's report of his work on 203 years of English rainfall records evoked the highest interest and will inspire further research in that direction. Mr. Eric R. Miller showed occurrence frequencies of cyclonic and anticyclonic air masses as related to the somewhat indefinable term "equinoctial storm." In another paper he sketched some of the early weather work (1837–44) of Elias Loomis, of Western Reserve College, at Hudson, Ohio. In contrast to the pioneering investigation of Loomis, Mr. E. A. P. Raab gave an account of the teaching of elementary meteorology at Burgard Vocational High School, Buffalo, N. Y., one of the most modern institutions of to-day. Charts exhibited by Mr. J. B. Kincer showed the progress and intensity of the drought over the United States in 1930, and Dr. W. J. Humphreys explained general causations of droughts and their equalization in other parts of the globe. Dr. Charles F. Brooks was reelected secretary, and Mr. Willis Ray Gregg was reelected treasurer. The following were elected councilors for 1931–33: Oliver L. Fassig, S. P. Fergusson, Sampaio Ferraz, John A. Fleming and George A. Loveland.

SECTION C (CHEMISTRY)

(*Report from H. P. Lankelma*)

All the sessions of Section C were held jointly with the Cleveland Section of the American Chemical So-

ciety on Tuesday. A program of seventeen papers dealing with various branches of chemistry was presented. At the forenoon session Leo Friedman discussed the results of measurements of diffusion velocities in agar and gelatin and their relation to theories of gel structure. O. F. Tower described his work on the formation of Liesegang rings of manganese and nickel sulfides in gelatin and agar. R. J. Anderson presented a brief summary of four years' work on the "Chemistry of Biologically Active Lipoids from Tubercle Bacilli." Subcutaneous injection of small quantities of these lipoids into healthy animals leads to the formation of tubercular tissue. The chemical composition of the different lipoid fractions was discussed. H. S. Taylor spoke on "The Activation Energy of Adsorption and Catalytic Activity." The application of activation energy to explain different types of adsorption and to the coordination of adsorption with catalytic activity was discussed. The opening address of the afternoon session was delivered by S. C. Lind, retiring vice-president for Section C. It dealt with theories of the origin and the cracking of petroleum hydrocarbons. James F. Norris presented a paper by himself and George Thomson dealing with cracking temperatures and cracking rates of certain pentanes and pentenes. The general problem of the relation of chemical structure to cracking temperature was discussed. J. A. Nieuwland pointed out that boron fluoride forms addition products with a large number of types of organic compounds especially in the aliphatic series. The addition compounds formed with alcohols constitute a new group of organic acids. H. H. Beard discussed a series of experiments carried on by himself and V. C. Myers on "Inorganic Iron Supplements in Nutritional Anemia." Oliver Kamm, in connection with Irvine W. Grote, presented a summary of progress recently made in the purification of the two hormones from the posterior pituitary gland. At the evening session Edgar C. Britton, of the Dow Chemical Company, discussed the hydrolysis of halogenated aromatic hydrocarbons. The effect of temperature and catalytic surfaces on the nature of the products was shown and possible theories to account for their formation were presented.

SECTION D (ASTRONOMY)

(Report from Philip Fox)

The program of Section D, which held sessions on Tuesday and Wednesday, was the most extensive that has been presented without the presence of the affiliated American Astronomical Society. Attendance at the sessions averaged about fifty. D. W. Morehouse, vice-president for this section, presided. Several papers dealt with the recently discovered planet Pluto. S. B. Nicholson and N. U. Mayall find the period to be 247.7 years; distance, 39.46 A. U.; perihelion passage, 1,989; eccentricity 0.25; and mass, 1.08 times that of the earth. Walter Bartky presented new and important equations for probable error of orbital elements in terms of probable error of observations. An important paper for Section D was Roger Lowell Putnam's lecture at the general session Wednesday evening on searching out Pluto. It is interesting to note that the discovery of Pluto was truly an institutional enterprise, in which many participated. The approaching opposition was the basis of a paper presented by F. H. Seares, who pointed out differences of color coefficients and scale correction of various observers. The Leonid meteors were the subject of two papers. About 20,000 of these reach the earth annually, counting only those bright enough to attract attention. H. T. Stetson reported on a continuation of his observations on the close correlation between intensity of radio signals and the sun-spot curve; the best radio reception was in midsummer, closely following a low ebb of solar activity. There were several papers on spectroscopy. Joel Stebbins stated that the photoelectric cell is now sensitive to the equivalent of a standard candle about 3 miles away. If the candle light were as white as that of some stars it could be detected at twice this distance. At a joint session of Sections L and D and the History of Science Society the retiring vice-presidential address for Section D was presented by Harlow Shapley, on "Galactic Explorations," and Philip Fox gave a paper on the Mensing collection of historical instruments in the Adler Planetarium and Astronomical Museum. A number of members of Section D visited the establishment of the Warner and Swasey Company, where many great telescopes have been built. J. J. Nassau, the local representative for this section, received visitors at the Warner and Swasey Observatory, Case School of Applied Science. A third focus of interest was the interferometer house of Case School, where Dayton C. Miller continues observations on the ether-drift experiments.

SECTION E (GEOLOGY AND GEOGRAPHY)

(Report from Kirtley F. Mather)

Section E held three sessions on Thursday and Friday. None of the organizations related to this section were in session in Cleveland, but about seventy-five geologists attended the meeting, and twenty-seven papers were listed on the program. Edson S. Bastin, of the University of Chicago, vice-president for the section, presided at the Thursday sessions, and Charles N. Gould, state geologist of Oklahoma, was in the chair during the Friday morn-

ing session. The address of the retiring vice-president, George F. Kay, of the University of Iowa, was presented Thursday afternoon. The annual dinner was greatly enjoyed by forty geologists in the Hotel Cleveland on Thursday evening. Dr. Bastin was toastmaster and called on Dean Kay, Professor J. E. Hyde (of Western Reserve), Professor F. R. Van Horn (of Case School), Professor W. H. Hobbs (of Michigan), Professor Kirtley F. Mather (of Harvard) and Dr. Arthur Bevan (state geologist of Virginia) for remarks. Abstracts of all papers presented will be published in the March issue of the *Bulletin of the Geological Society of America*, and Dean Kay's address will appear in full in an early issue of that periodical. The thanks of all in attendance are due to Professors Hyde and Van Horn for the excellent arrangements for the meetings.

SECTION F (ZOOLOGICAL SCIENCES)

(*Reports from Geo. T. Hargitt, J. J. Davis, A. F. Burgess, Norman R. Stoll and J. M. Shaver*)

The American Society of Zoologists held sessions for the reading of papers on Tuesday, Wednesday and Thursday mornings. Exclusive of joint sessions ninety-four papers were read, distributed as follows: Comparative and general physiology, 46; cytology, 10; embryology, 14; protozoology, 4; ecology, 6; parasitology, 10; miscellaneous, 4. Several sections held sessions simultaneously, four on Tuesday and Wednesday and two on Thursday. The attendance was large, frequently running over one hundred for each section. Tuesday afternoon was devoted to informal demonstrations, about twenty papers being presented in this manner, with excellent attendance. By this method the material and illustrative aids are arranged for easy observation and the author discusses whatever phase of the work appeals to his audience; opportunity for discussion is unlimited. A joint session was held with the American Society of Parasitologists on Tuesday morning, and one with the Ecological Society of America on Wednesday morning. The meeting places and appointments were very satisfactory, and the thanks of the American Society of Zoologists and of Section F are extended to the local committee, the university and others who contributed to this success. The annual biological smoker occurred Tuesday evening, a most enjoyable social gathering, with several hundred biologists present. The museum rooms afforded an excellent place for such a gathering, and the various exhibits were open for inspection. Thanks are extended to the museum and the local biologists for their gracious hospitality on this occasion. On Wednesday evening a dinner for all zoologists was held at the Hollenden Hotel, attended by two hundred, following which was delivered the address of the vice-president for Section F, William A. Riley, of the University of Minnesota, speaking on "Some Present-day Problems in Zoological Teaching." The address of Dr. Riley will appear in full in SCIENCE.

The Entomological Society of America held its twenty-fifth annual meeting on Tuesday and Wednesday, with 44 interesting papers covering almost every phase of the vast field of entomology. C. T. Brues presented a study on the composition and origin of the insect fauna of hot springs in the Western United States. It was brought out that bacterial plants without chlorophyl were found in springs at 89° C. and blue green algae at 63.5° C., but that plants with chlorophyl were not found in springs with a temperature higher than 52° C. One species of mite, which is a typical hot springs inhabitant throughout the world, was found at 50.8° C. The temperature maximum appears to be about the same for plants with chlorophyl and for insects. C. H. Curran emphasized the importance of complete monographic papers on taxonomy, rather than scattered articles in serial publications. E. P. Felt discussed the possibility of using numerals or other symbols in entomological taxonomy. That would facilitate arrangement of collections and would make it easier to recognize the taxonomic position of any insect. An interesting and enlightening illustrated talk was given by H. B. Hungerford, on entomologists and museums which he had recently visited in Europe. Herbert Osborn gave an account of early entomological work in Ohio. One of the cicadas was reported as a new asparagus-fern pest of considerable economic importance in Florida, according to J. W. Wilson. A. A. Granovsky reviewed recent work on the relation of insects to the transmission of plant diseases. C. L. Metcalf discussed common insects that attack man, particularly the Diptera, with special reference to the time of year and time of day at which the various species appear and are annoying. I. A. Parfentjen demonstrated an apparatus to ascertain the adhesiveness of insecticide dusts. There were two useful exhibits at this meeting, one on methods of mounting Coleoptera, and one on the preparation of pyrethrum for insecticidal uses. H. J. Quayle gave the annual invitational address before an audience of over one thousand persons. His title was "Entomologists in Subtropical Countries." Officers of the Entomological Society for 1931 are: *President*, J. W. Folsom; *secretary-treasurer*, J. J. Davis.

The meeting of the American Association of Economic Entomologists was largely attended from all sections of the United States and from Canada. The

section of apiculture held its sessions on Monday, giving special attention to the effects of high temperature upon bees. In the afternoon there was a trip to the plant of the A. I. Root Company, at Medina, Ohio. The plant quarantine and inspection section met on Tuesday. The problem concerning the Mediterranean fruit fly was summarized by W. C. O'Kane. Quarantine relations of the European corn borer and the gipsy moth were presented in several papers and others dealt with the certification of apples for export to Great Britain. The general sessions of the economic entomologists were held on Wednesday and Thursday, covering a wide range of subjects. There were two papers on greenhouse insects, one on insects affecting domestic animals and a long series on insects affecting deciduous fruits. The codling moth and the removal of arsenical residues received special attention. There were eleven papers on insecticides. Pyrethrum extracts were discussed in three papers. The utilization of radioactive lead as an indicator of the solubility of acid lead arsenate was of special interest. There were four papers on forest and shade-tree insects and many on insects affecting cereal and forage crops. The European corn borer easily held first place among these. Three papers on insects affecting household and grain insects were presented. In the 19 papers on miscellaneous subjects, those on biological control were of special interest. The section of extension met on Thursday evening, holding a symposium on effects of the 1930 drought upon insect populations. The following officers were elected: *President,* J. S. Houser; *first vice-president,* W. E. Hinds; *secretary,* A. F. Burgess, Melrose Highlands, Mass.

The American Society of Parasitologists held its sixth annual meeting on Tuesday, Wednesday and Thursday. Consistently large audiences, frequently over seventy, heard a group of papers that reflected current interests in the American parasitological field. There was a large attendance at the address of the retiring president, W. W. Cort, of the Johns Hopkins University, on "Recent Investigations on the Epidemiology of Human Ascariasis." Dr. Cort summarized epidemiological researches in China and Panama, where the ascaris findings were a by-product of work on the human hookworm problem, and devoted special attention to more recent investigations in Virginia, Kentucky and Tennessee, which have emphasized an endemic public-health problem of first importance. This paper was followed by the annual tea of the society. Of especial interest were two joint sessions with the American Society of Tropical Medicine, one largely concerned with protozoological studies, while the other dealt with helminthology. The former included three papers on infections by *Endamoeba histolytica,* two papers on the morphology of trichomonad flagellates, an exceptionally well-rounded study of a leucocytozoon from the wild duck and two papers on the treatment of protozoan infections. The helminthological program included two papers on *Diphyllobothrium latum* (broad tapeworm) in North America and four on hookworm, dealing with its distribution in man in Kentucky, the slow rate of loss of worms in persons with "undisturbed" infections, and newly observed blood-sucking habits of dog hookworms. Other phases of medical interest in the nematodes were presented. The Tuesday morning session was held jointly with the American Society of Zoologists. The papers of this session, and also those given on Thursday morning, generally dealt with zoological aspects of parasitology, including problems of classification, development and ecology. There were 61 papers on the society program; 3 in entomology, 40 in helminthology and 18 in protozoology. Officers for the ensuing year are as follows: *President,* W. A. Riley; *vice-president,* A. C. Chandler; *secretary-treasurer,* N. R. Stoll, Rockefeller Institute, New York, N. Y.; *council members,* L. R. Cleveland (1 year), H. E. Ewing (2 years), W. W. Cort and E. C. Faust (4 years).

The Wilson Ornithological Club met on Monday and Tuesday with an unusually full program of 33 papers. Approximately 175 persons attended the sessions. The range of material treated in the papers was very great, covering distribution questions, territory, census methods, results of migration, physiology, ornithological exploration, morphology, history, genetics, nesting habits, food habits and other topics. Among the papers was one by Chester K. Brooks, describing, with motion pictures, the young of the Ross snow goose (*Chen rossi*) in captivity. This is the first time that the young of this goose has been raised in captivity in America. Its nesting place is still unknown and our knowledge of its young has been based on old-world investigations similar to those of Mr. Brooks. Another very significant paper was on bird temperatures by S. Charles Kendeigh. It dealt with the establishment of temperature control in the house wren. One of the high lights of the meeting was the very thorough and carefully worked-out study of survival and reproduction in a song-sparrow population during one season, by Mrs. Margaret M. Nice. She dealt to a very great extent with marked birds, and presented much information concerning their territories and the shifts involved during the spring and summer of 1930. Another special feature of the meeting was the dinner address given by Harry Oberholser, of the U. S. Biological Survey.

SECTION G (BOTANICAL SCIENCES) AND RELATED ORGANIZATIONS

(*Reports from S. F. Trelease, Arthur J. Eames, A. S. Foster, F. E. Denny, A. H. Povah, H. S. Conard, W. A. Whitney and Walter Thomas*)

Section G on Tuesday afternoon presented a session of invited papers reporting the results of research in several fields of botanical sciences. B. O. Dodge reported his studies on hybridization and inheritance in the Ascomycetes. Lewis Knudson discussed mycorrhiza from the point of view of physiology. Karl Sax discussed chromosome structure and explained his new theory of the mechanism of crossing over. E. N. Transeau summarized his extensive studies of the vegetation of the Ohio Valley.

The Botanical Society of America held an unusually successful meeting from Monday to Thursday, with a membership attendance of over 300. Five sections held very well-attended meetings on three days. The annual dinner for botanists was held on Wednesday evening, with an attendance of 282. President L. W. Sharp presided, and Retiring President Margaret C. Ferguson delivered the presidential address. A report on the summer meeting of the society was presented by G. B. Rigg. Announcement was made of the election of the following officers: *President,* C. J. Chamberlain; *vice-president,* E. W. Sinnott; *treasurer,* G. E. Nichols; *editor,* H. C. Cowles.

The meetings of the general section of the Botanical Society were held on Tuesday, Wednesday and Thursday mornings, with Professor J. H. Schaffner as chairman. In the field of morphology, papers treating of such topics as the ontogeny and morphology of the inflorescence of *Zea Mays*, the developmental interpretation of cataphylls in the Angiosperms and the embryogeny of certain dicotyledons were presented. Of paleobotanical interest was a paper on a lignitic fragment from New Jersey, the anatomical structure of which was interpreted as showing it to possess definite Cycadeoidean affinities. Papers of cytological interest included an analysis of chromosome behavior in certain apogamous and parthenogenetic species and the bearing of this upon the probable hybrid origin of these forms, and a detailed study of the finer structure of the chromosomes of *Tradescantia zebrina* Hort. Of genetical interest was a report on experiments that had resulted in 100 per cent. sex reversal in hemp. The field of anatomy was represented by papers on such topics as the development and histology of traumatic tissue in the giant cactus, the structure of certain Cycadofilicean roots and the development of tissues in the stem and root of *Equisetum scirpoides*. A paper which aroused considerable discussion gave an account of the bacterial population found, by means of very special technique, in anthracite coal. The important question as to whether these micro-organisms had reached their position in the coal during ancient or modern times appears to require further investigation.

Three sessions of the physiological section of the Botanical Society were held. Two papers dealt with the effect of wounding upon subsequent growth: Eloise Gerry reported the effects of fire upon subsequent growth and resin production in pine trees and H. L. Chance upon the growth response of plants subjected to severe wounding of leaves. Three papers dealt with nutrition: E. F. Hopkins presented results of experiments showing the necessity of manganese for the growth of Chlorella; D. J. Verda and others showed that absorption of sugar from a culture solution by Spirogyra was related to the nature of the inorganic salts present; L. Knudson and D. G. Clark reported on further experiments on the use of sugar in inducing germination of orchid seeds. T. Kerr made use of the micro-injection method to study the effect of various ions on streaming protoplasm in Trianea. O. F. Curtis and H. T. Chang showed that the flowering response exhibited by celery to different temperatures occurred when only the crown of the plant was exposed to the controlling temperatures. It was found by B. S. Walker that estrogenic substances (*i.e.*, those having an effect similar to that of the female hormone in animals) were present in various plant extracts, especially in extracts from actively growing parts. A. A. Dunlap gave a report on carbohydrate changes in tobacco leaves as a result of mosaic disease. J. B. Overton described the seasonal distribution of water-conducting and gas-filled portions in the woody tissue of willow and alder. F. W. Von Ohlen used microchemical methods to study the changes in soybean seeds during germination. H. J. Fuller obtained a stimulative effect upon the growth of tomato plants by the use of ultra-violet light. Unusual forms of root growth exhibited by bog plants were discussed by G. B. Rigg and E. S. Harrar. Abstracts of most of the physiological papers appeared in the December, 1930, issue of the *American Journal of Botany*. The officers elected at this meeting are: *Chairman,* G. J. Peirce; *vice-chairman,* C. G. Deuber; *secretary-treasurer,* J. M. Arthur; *members of the physiological board,* L. Knudson and E. N. Transeau.

Fifteen papers were read before the mycological section of the Botanical Society, among which may be mentioned a very interesting paper by C. Frederic Andrus on fertilization in the rusts, Cummins' work on the taxonomy of *Phragmidium*, Howard's two

papers on the physiology and cytology of the Myxomycetes and a paper by M. A. Rice on *Chrysomyxa*. A third of the papers were cytological. The most outstanding feature, however, was an invitational program celebrating the centenary of the birth of Anton de Bary, in which the American Phytopathological Society joined. For the ensuing year, Dr. Fred J. Seaver was elected chairman and Dr. Leon H. Leonian secretary.

The systematic section of the Botanical Society, under the chairmanship of C. C. Deam, state forester of Indiana, held four sessions. On Tuesday morning reports of the Fifth International Botanical Congress were given by F. D. Kern, A. J. Grout, T. G. Yuncker and E. D. Merrill. About 75 persons attended. The Wednesday morning session was devoted to a symposium on glacial relicts. About 150 persons attended. The Thursday morning session was devoted to a round-table discussion of local botanical manuals, with an attendance of about 75. The general session of this section included papers in a variety of fields and was attended by about 75. Much interest was shown in the three invitation sessions, and much more time might have been spent profitably in discussion of the very interesting papers presented. The general session was of more especial interest to systematists in the narrower sense. For the New Orleans meeting B. C. Tharp was elected chairman and W. T. Penfound, of Tulane University, secretary.

The American Phytopathological Society held its twenty-second annual meeting from Tuesday through Thursday, with the largest attendance for many years. Ninety new members were enrolled, bringing the membership to 837. The following officers were elected: *President,* Max W. Gardner; *vice-president,* L. M. Massey; *councilor,* G. W. Keitt. The *secretary-treasurer* (F. C. Meier) and *editor-in-chief of Phytopathology* (H. B. Humphrey) continue their unexpired terms. The 83 papers delivered before the society's several sessions may be grouped as follows: General and invitation papers, 4; vegetable diseases, 22; cereal diseases, 20; fruit diseases, 10; tobacco diseases, 6; diseases of miscellaneous crops, 21. Two joint sessions were held, one with Section G of the American Association and the other—designated as the Heinrich Anton de Bary (1831–1888) Centenary Memorial program—with the mycological section of the Botanical Society of America. A special session was held on extension work in plant pathology with special emphasis on methods and agencies used in reaching the people. The last part of the session on tobacco diseases was devoted to discussion of symptoms, diagnosis and control of these diseases, and several of those in attendance presented specimens, photographs and stereopticon slides. Approximately 122 pathologists and their friends assembled for their annual dinner on Tuesday evening. Retiring-president H. S. Fawcett introduced W. H. Weston, Jr., as toastmaster. A selection of songs and several "stunts" were followed by a discussion of the proposed memorial to E. J. Butler, eminent British mycologist and plant pathologist at the Imperial Bureau of Mycology, by L. R. Jones, Donald Reddick, and others. Motion pictures portraying agricultural activities in the Union of Socialistic Soviet Republics, exhibited by J. G. Dickson, concluded the program.

Full abstracts of most of the papers presented at this meeting will appear in *Phytopathology* for January, 1931. A few of the numerous points brought out, chosen at random, are mentioned below. Solid carbon dioxide ("dry ice") was held by Charles Brooks to be a possible means of controlling transit diseases of fruits and vegetables through the increase of the CO_2 content of the air as well as by the added refrigerant. H. S. Fawcett pointed out the importance of investigations on the effect of known mixtures of microorganisms in phytopathology. F. C. Stewart and H. Glasgow discussed aphids as vectors of leaf roll among sprouting potato tubers. The distribution of the latent virus in tubers of commercial potatoes was discussed by Grover Burnett and Leon K. Jones. E. S. Clark and Wm. H. Martin discussed the effect of the depth of planting and of soil moisture on the development of Rhizoctonia on the potato. A paper on seed treatment for the damping off of tomatoes was read by James J. Horsfall. Michael Shapovalov reported on the growth rate of tomatoes affected with yellows. The artificial hybridization of *Puccinia graminis tritici* and *P. graminis secalis* was announced by Margaret Newton, T. Johnson and A. M. Brown. The nuclear association of the aecium of *Puccinia graminis* was described by W. F. Hanna. The germination of wheat stem rust teliospores developed in the greenhouse was reported by Thorvaldur Johnson. The effect of mineral nutrition on the reaction of wheat varieties to leaf rust was discussed by K. D. Doak. The effect of temperature and light on the development of the uredinial stage of *Puccinia graminis* was discussed by Leonard W. Melander. The development of crown gall, hairy root and callus under controlled conditions was described by A. J. Riker, W. M. Banfield and G. W. Keitt. E. M. Hildebrand discussed the life cycle of the hairy-root organisms on the apple in relation to pathogenesis. M. W. Gardner and R. C. Baines reported on the cultural characters and host range of the apple sooty-blotch fungus. Artificial infections of apple fruits with the scab fungus were described by C. O. Bratley. W. M. Banfield described the relation of root-feeding arthropods to crown-gall infection on raspberries.

Duke V. Layton and J. J. Wilson described three new wilt-resistant watermelon varieties. The common squash bug was accused, by L. Ray Robinson and B. L. Richards, of responsibility for a new and destructive disease of cucurbits. Two species of *Septoria* were reported by L. C. Cochran as being responsible for late blight of celery. Correlative studies on the bacteriology of bean mosaic and seed transmission of the virus were discussed by Ray Nelson. The use of fertilizers in reducing the loss from the *Aphanomyces euteiches* root rot of peas was described by O. M. Haenseler. Endohydrosis of forcing cucumbers and its control were discussed by Ray Nelson. Melville T. Cook called attention to certain undescribed symptoms of mosaic in Porto Rican tobacco. Four new mosaics of tobacco were described by H. H. McKinney. The epiphytology of tobacco mosaic in North Carolina was described by Frederick A. Wolf. P. D. Peterson pointed out the influence of the three types of tobacco mosaic on the plastid pigment and chlorophyllase content of tobacco leaves. Walter N. Ezekiel, J. J. Taubenhaus and J. F. Fudge discussed nutritional studies on *Phymatotrichum omnivorum*. The development of root rot in cotton planted at different dates was described by B. F. Dana and H. E. Rea. F. L. Wellman reported on progress of the *Fusarium* wilt organism inside the rhizomes of banana plants. Cecil Yarwood reported on the powdery mildew of red clover. J. L. Weimer discussed alfalfa mosaic. Varietal susceptibility, distribution and control of yellow dwarf of onions was discussed by W. J. Henderson. The effect of ultra-violet radiation on representative species of Fusarium was described by Alice A. Bailey. The effect of bean extract on *Colletotrichum lindemuthianum* was described by E. S. Reynolds and B. S. Miller. C. L. Lefebvre described a fungous parasite of the European corn borer. The Dutch elm disease was reported for Ohio by Curtis May, O. N. Liming and Thelma Alexander. W. Howard Rankin described new methods for determining rate of decay behind cavity fillings in trees. Oxides of unsaturated hydrocarbons for the eradication of barberry and other pests were brought forward by R. B. Harvey. C. D. Sherbakoff described the wheat diseases of Tennessee. F. J. Greaney announced that sulphuring prevented black chaff of wheat. Sweet corn resistant to *Diplodia zeae* was described by Glenn M. Smith and John F. Trost. I. E. Melhus and Glen N. Davis reported on nodal infection with the cornsmut organism. G. W. Keitt reported on apple-scab spraying. P. A. Young discussed penetration and toxicity of petroleum-oil sprays. The presence of water-soluble arsenic in spray materials was discussed by H. C. Young. A. L. Pierstorff and H. C. Young announced results with new sulphur dusts for apple-scab control in Ohio. S. E. A. McCallan and Frank Wilcoxon described the relation of hydrogen sulphide to the fungicidal action of sulphur.

The annual dinner of the American Society of Plant Physiologists was held on Monday evening. President H. R. Kraybill presided, and 95 members were present. Charles A. Shull announced the second award of the Stephen Hales prize to Wightman W. Garner. R. B. Harvey announced that Rodney H. True had been elected to the Charles Reid Barnes life membership. In accordance with the conditions of the Stephen Hales award, D. R. Hoagland, the recipient of the 1929 award, gave an address after the dinner, entitled, "The Absorption of Mineral Elements by Plants in Relation to Soil Problems," which will be published in *Plant Physiology* for July, 1931. Thirty-nine papers were presented in the regular sessions, to an audience of from 75 to 100. There were 9 papers presented at a joint session with the American Society for Horticultural Science, to an audience of 300, and four papers were given at a joint session with Section G of the association, the Botanical Society of America and the American Phytopathological Society.

At the first session of this society, F. M. Andrews described how he had succeeded in retarding longitudinal and diametric growth by means of force applied longitudinally as well as transversely to actively growing roots of *Zea Mays* seedlings. A. H. Hendrickson and F. J. Veihmeyer reported that roots do not penetrate soils containing less moisture than the permanent-wilting percentage and that the residual moisture content at permanent wilting was governed by the nature and structure of the soil and was not influenced by evaporation conditions. Elizabeth Dean reported greenhouse studies showing that the position and extent of the root system were greatly influenced by aeration and soil type. The response to oxygen supply varied with different plant species. William A. Beck reported that the osmotic value of tissues at incipient plasmolysis, when cane sugar was employed as plasmolyzing agent, was an index of physiological activity. At the Monday afternoon session John F. Trost and others reported that both genetic and induced barrenness in Dent corn are associated with a high content of soluble nitrogen and of starch in all organs. G. H. Dungan presented results of experiments which indicated that corn tillers serve to nourish the main plant. William H. Eyster reported on the Argentia Chlorophyl pattern in maize. V. H. Morris presented comparative results from different methods of studying the moisture content of different parts of the corn plant.

At a joint session with the American Society for Horticultural Science J. W. Crist and Marie Dye reported that albino rats fed on asparagus tips as sole source of vitamin A grew in proportion to the amount of chlorophyll present. L. F. Graber described the effect of cultural practices, including defoliations, on the food reserves of agronomic plants. Ruth Addoms and G. T. Nightingale reported that calcium-deficient tomato plants absorbed little or no nitrate, even when an abundance was present in the nutrient solution. A. E. Murneek presented data on the quantitative distribution and seasonal fluctuation of nitrogen in apple trees. E. C. Auchter gave a review of the literature dealing with the propagation of fruit trees from stem and root cuttings.

At the Wednesday morning session Joseph C. Ireland and Frank M. Durbin demonstrated their use of a Burt photoelectric cell in making a continuous record of the candle-power of sunlight. S. V. Eaton reported a close correlation between weights of tops and roots and weight of nodules in soybean, all decreasing with decreasing day length and also with clipping. H. H. McKinney and W. J. Sando gave results of studies on the effects of light and temperature on wheat. Warren B. Mack and Burton E. Livingston presented experiments showing that the effect of ethylene on CO_2 production by young wheat seedlings might be either zero, positive or negative, according to the oxygen pressure in the medium. H. L. van de Sande Bakhuyzen presented evidence that root hairs, epidermis, sclerenchyma and xylem of *Vicia Faba* were electrically neutral, while cortex and phloem were negative. He pointed out that transfer of water and certain solutes through the endodermis might be governed by the distribution of electric charges. The same investigator reported experiments on the stabilizing influence of urea on isoelectric potato tissue and suggested a theory of permeability on the basis of his findings. J. D. Sayre discussed the measurement of bound water in plant tissues. Maurice Sullivan reported that the time factor was more influential than the concentration factor in producing leaf drop in potted rose bushes exposed to ethylene. Oran Raber suggested that the effect of liver extract in checking the etiolation of plants in darkness might be brought about by the same mechanism that influences hemoglobin content of human beings fed on liver extract.

At the Wednesday afternoon session Walter Thomas reported that the ratio of starch to nitrogen is, in *Pyrus Malus*, the most sensitive index of internal physiological conditions caused by differential fertilizer treatment with respect to nitrogen, phosphorus and potassium. C. H. Rogers described experiments with maize showing that little or no iron entered tissues having a pH value at or above the precipitation point of iron, whereas large quantities of iron might be found in tissues having a pH value below this point. K. D. Doak and P. R. Miller found, in eight sorghum varieties, that both phosphorus and nitrogen influenced anthocyanin production while potassium showed no effect. Geo. W. Scarth and R. D. Gibbs gave a preliminary report on the distribution and movement of water in *Populus tremula*, *Pinus banksiana* and *Abies balsamea* grown in Quebec.

ORGANIZATIONS RELATED TO BOTH SECTIONS F AND G

(*Reports from P. C. Mangelsdorf, A. O. Weese, Geo. D. Fuller, Alfred Emerson, H. J. Van Cleave, P. W. Whiting and A. I. Ortenburger*)

The American Society of Naturalists held a symposium on Thursday afternoon, on "The Future of Man in the Light of His Past." A. B. Kidder presented the views of an archeologist. He emphasized the fact that civilizations fall because of a failure to solve the social and economic problems arising from changing culture and suggested that the success of present civilization will depend on the ability of biologists and humanists to coordinate their efforts in solving these problems. William F. Ogburn spoke on the subject from the view-point of a sociologist. He predicted that the society of the future will be one of greater and greater change and complexity; that ethical conduct will become a matter of intelligence, and right and wrong a matter of social expediency rather than of law. E. M. East concluded the symposium with the views of a geneticist. He predicted a stationary population within the next five hundred years; increased racial intermixture with an accompanying increase in heterozygosity; the control of all parasitic diseases and many non-parasitic ones, and a continued thwarting of natural selection until eugenic measures become a matter of necessity. All the speakers treated the subject in a humorous vein, yet each one presented a serious and searching analysis of the problem. S. J. Holmes was elected president for 1931 and E. J. Kraus vice-president. The annual dinner was held on Thursday evening. Following the dinner an address was given by President A. F. Blakeslee.

The Ecological Society of America met on Tuesday, Wednesday and Thursday, with an attendance varying from 50 for the first morning session to 200 for the joint session with the Botanical Society of America, on Wednesday afternoon. The notable features of the meetings were the joint meetings with the Botanical Society of America and with the American Society of Zoologists and the three symposia. The first of these, in charge of President Weaver, was on "Ecology in Relation to Agriculture," the second, arranged by

H. C. Cowles, was on the "Ecological Interactions between Plants and Animals," while the third, arranged by W. E. Allen, dealt with "Environmental Units and Their Terminology." At the close of the last symposium a committee was appointed to consider the question of ecological nomenclature and to report to the next meeting of the society. The ecologists' dinner was held on the evening of Thursday, January 1, following which President J. E. Weaver gave his retiring address entitled "Who's Who on the Prairie," which was a careful consideration of the composition and relation of the grassland communities of the Middle West. The following officers were elected: *President,* A. O. Weese; *vice-president,* Francis Ramaley; *secretary-treasurer,* A. E. Emerson, University of Chicago.

The American Microscopical Society held its forty-ninth annual meeting on Wednesday. The following officers were elected for 1931: *President,* Harley J. Van Cleave; *first vice-president,* L. E. Noland; *second vice-president,* Elda R. Walker; *secretary* (3 years), James E. Ackert, Kansas State Agricultural College; *elective member of executive committee* (3 years), Horace W. Stunkard. The custodian, Henry B. Ward, reported that the Spencer-Tolles Fund is now in excess of $15,000. Drs. Ackert and Van Cleave were named to represent the society in the council of the American Association.

The Genetics Sections of the American Society of Zoologists and the Botanical Society of America met from Monday to Friday. Joint sessions with the Geneticists Interested in Agriculture, with the American Society of Agronomy and with Section O of the association were held on Monday. Problems of inbreeding were considered from various angles. Regular sessions for reading of papers were limited to forenoons. Attendance was sometimes as great as 200. Twenty-six papers were presented and fourteen were read by title. The afternoons were devoted to demonstrations. Interest centered in cytological preparations as correlated with genetic phenomena. Translocations in Drosophila and X-Y pair in man were shown by T. S. Painter (University of Texas) and the location of an interchange between two non-homologous chromosomes in maize was demonstrated cytologically by Barbara McClintock (Cornell). Stages in Drosophila spermatogenesis were shown by Bessie League (University of Texas). An outstanding feature of the meeting was a paper on "Cytological Evidence of Genetical Relationships in Oenothera," by Ralph E. Cleland (Goucher College). The most spectacular contribution was undoubtedly "Evidence of Divisibility of the Gene," presented by I. J. Agol, director of the Timiriazef Biological Institute, Moscow, U.S.S.R. Dr. Agol is spending the year in the laboratory of H. J. Muller (University of Texas). He has attained noteworthy results since his arrival in this country last fall. Officers for 1931 are as follows: *Chairman,* L. J. Stadler; *secretary-treasurer,* P. W. Whiting; *society representative,* E. W. Sinnott. The report of the committee on organization appointed at Des Moines was accepted and the officers, constituting an executive committee, were empowered to draw up a constitution and to proceed with the organization of an independent society. This society is to come into being at the next meeting (New Orleans).

The Phi Sigma Biological Research Society devoted Wednesday to the transaction of business and Thursday was devoted to the reading of papers by student members. In keeping with the policy inaugurated at the last convention, of emphasizing the scientific rather than the honorary features of this society, a program of unusual interest was presented. Over 40 papers were read by delegates from the 29 active chapters. The address at the annual dinner was given by Dr. A. S. Pearse, on "Research as a Factor in Modern Science and Life." Paul A. Warren was elected vice-president. A. I. Ortenburger, of the University of Oklahoma, was reelected secretary.

SECTION H (ANTHROPOLOGY) AND RELATED ORGANIZATIONS

(*Reports from C. H. Danforth, A. Irving Hallowell and Dudley J. Morton*)

The American Anthropological Association, the American Folk-Lore Society and the American Association of Physical Anthropologists all met with Section H this year on Monday, Tuesday and Wednesday. The opening session of the American Anthropological Association was given over to reports on the anthropological activities of various organizations, committees and institutions, as follows: National Research Council, F. C. Cole; Social Science Research Council, E. Sapir; Fellowships, A. M. Tozzer; State Archeological Surveys, C. Guthe; Chicago World's Fair, F. C. Cole; Institute of Human Relations, C. Wissler; Laboratory at Santa Fe, A. V. Kidder; American School of Prehistoric Studies in Europe, G. G. MacCurdy; the new Ethno-botanical Repository at the University of Michigan, M. R. Gilmore. A session was devoted almost wholly to archeological subjects, some North American, some North African and some European. Byron Cummings reported on Kiva types near Navajo Mountain. A. W. Pond described a paleolithic station and a Mousterian quartzite quarry site in the Sahara. R. W. Erich presented a report on the Second Central European Expedition of Peabody Museum (Harvard) and the University of Pennsylvania. B. F. Whorf brought forward recent

archeological and linguistic findings from Central Mexico. Another paper of linguistic interest was read by C. M. Rosenquist, on linguistic changes in the acculturation of Swedes in Texas. Folk-lore was represented by papers on Philippine folk tales, white spirituals in the rural portions of our Southern states and New-World Negro culture. Several papers dealt with ethnological questions, from various regions of the earth and there were other papers of still more general interest. Readers are reminded that copies of the general program of the Cleveland meetings may be secured free by writing to the Washington office of the association, Smithsonian Institution Building.

Officers of the Anthropological Association were elected as follows: *President,* G. G. MacCurdy; *vice-presidents,* R. Linton, C. Guthe; *secretary,* J. M. Cooper; *treasurer,* E. W. Gifford; *editor,* R. G. Lowie; *associate editors,* E. W. Gifford, F. G. Speck; *executive committee,* R. F. Benedict, F. W. Hodge, A. V. Kidder; *representative in Social Science Research Council,* E. Sapir; *representatives in National Research Council,* J. M. Cooper, T. W. Todd; *representatives in A. A. A. S. council,* E. A. Hooton, A. Hrdlička. The following officers were elected by the American Folk-Lore Society: *President,* Franz Boas; *vice-president,* Stith Thompson; *treasurer,* L. A. White; *secretary,* G. A. Reichard; *editor,* R. F. Benedict.

Following the anthropologists' dinner on Tuesday evening, A. V. Kidder gave the retiring vice-presidential address for Section H. He discussed some aspects of his investigations at Pecos, New Mexico, and called attention to a very real interest in these studies shown by visitors. He emphasized the fact that a quite naïve interest sometimes develops into useful enthusiasm for this branch of science. Aleš Hrdlička, president of the Anthropological Association, then spoke, with illustrations, on his Alaskan studies of recent years, with special reference to the problem of the original peopling of the New World. Abundant evidence is now in hand to show that successive waves of migration passed eastward along the inhospitable Arctic and west Pacific coasts of Asia, then across the short stretch of water to the slightly less forbidding coast of Alaska. Among the many papers presented before Section H, of the association, on Wednesday was one by W. W. Graves on a study of 13,000 shoulder blades, including observations on about a thousand families. Definitely hereditary types were revealed, traceable from fetal life to old age. At the same meeting, L. Foster reported on his studies of pre-Spanish and modern dolicocephalic crania from San Juan Teotihuacan, pointing out that great caution must be exercised in attempting to trace the racial influence of the Spaniards. A paper by S. D. Aberle and one by Hortense Powdermaker dealt with birds and vital statistics among the primitive peoples of New Mexico and New Ireland, respectively.

At a joint session of Section H and the American Association of Physical Anthropologists T. Wingate Todd and his collaborators presented a series of papers dealing with the significance of ossification centers and epiphyses. It was emphasized that the earliest or latest date at which a process is completed may be far more significant than anything that can be learned from the mean. Problems of age, endocrine effects and disease were discussed from this viewpoint. Important considerations were presented concerning the adolescent growth jump in anthropoid and human types. This joint session closed with a review of the phylogeny of the lower and upper jaws from fish to man, by W. K. Gregory, who gave special attention to recent findings which close more completely the ever-narrowing gaps in this series.

The American Association of Physical Anthropologists held a very successful meeting. This young organization has developed from a suggestion made two years ago, at a New York session of Section H. It held its first meeting last year, with the American Association of Anatomists. The Cleveland meeting was its second annual meeting, held in conjunction with its parent organization, Section H. The meeting was opened by President Hrdlička, who summarized the progress thus far made. The organization now has about 90 members and appears to be very vigorous. There were reports of two committees that had been named to gather information concerning human and anthropoid material available for study in the United States and Canada. A wide range of problems were presented in the scientific program, from among which may be mentioned a report by A. Hrdlička, on a study of the humerus in relation to the incidence of intercondylar fenestrations, and to a heretofore unrecorded foramen occurring above the medial epicondyle. C. V. Noback discussed the appearance of ossification centers in a young gorilla and the growth curve of the same animal in comparison with that of the human child. L. D. Redway demonstrated the use of instantaneous color photography in the study of ophthalmic cases. Another paper, by H. U. Williams, dealt mainly with the histology of seven Egyptian mummies of about 1000 B. C. W. K. Gregory told of the anatomical expedition to Africa sent out under the auspices of Columbia University and the American Museum of Natural History. His presentation was amplified by motion-picture gorilla studies presented by Professor MacGregor, official photographer of the party, and by a brief account of feet

studies of the natives given by Dudley J. Morton. T. D. Stewart discussed dental caries in ancient Peruvian skulls. The papers mentioned here are taken at random.

SECTION I (PSYCHOLOGY)

(*Report from John E. Anderson*)

Section I held its sessions on Friday, January 2. The main address was given by Dr. Madison Bentley, of Cornell University, retiring vice-president for Section I, on "Psychology's Family Relations among the Sciences." After describing the complex interrelations of psychology with other sciences, particularly the diversity of the tasks undertaken and the multiplicity of interests shown by psychologists, Dr. Bentley pointed out that there is more give and take between the various sciences and more evidence of integration, than formerly. He said that as psychology values more and more its independence, husbands more and more its unique resources, and clarifies more and more its proper relations among the sciences it will deal more frankly and competently with certain functions and performances of the living organism which at present fall to the lot of no distinctive member of the whole large family of sciences. Three sessions were held, at which a total of 21 submitted papers were presented. Approximately a hundred persons were present at each session. The fields represented by these papers were as follows: general, 1 paper; experimental, 4 papers; genetic or comparative, 4 papers; educational, 5 papers; social, 1 paper; and abnormal or clinical, 6 papers.

SECTION K (SOCIAL AND ECONOMIC SCIENCES)

(*Reports from Charles F. Roos, Willford I. King, F. L. Roberts, Charles F. Schlatter, W. I. Myers, Hugh E. Agnew and E. W. Burgess*)

On Monday afternoon Section K held a joint session with Section A (Mathematics), the American Mathematical Society and the American Statistical Association. G. C. Evans, of the Rice Institute, delivered the opening address on "Simple Types of Economic Cycles and Crises." Using a price index number introduced by the French economist Divisia, Professor Evans showed that it is possible to produce many of the characteristics of economic crises by relatively simple mathematical postulates and analysis. Henry Schultz, of the University of Chicago, led the discussion of this paper and exhibited some statistical researches on the subject. In a paper on decomposing a time series into its progressive and cyclical components, Ragnar Frisch, of the University of Oslo, *pro tempore* at Yale University, developed a promising new operational method. Oystein Ore, of Yale University, led the discussion. In the final address of the afternoon Harold Hotelling, of Stanford University, criticized Bayes' theorem and agreed with R. A. Fisher that the theory of inverse probability must be wholly rejected and that the mathematical quantity which appears to be appropriate for measuring our order of preference among different possible populations does not obey the laws of probability. He proposed to make this quantity, which Fisher calls *likelihood*, the basis of studies regarding statistical inference. W. A. Shewhart led the discussion of this paper. All other contributions by members of Section K appeared on the programs of the American Statistical Association, the American Economic Association, the American Sociological Society, the American Political Science Association, the American Farm Economic Association and other societies that met in Cleveland at the time of the association meetings.

On Monday evening a group of mathematical economists met to form a new society, to be called the Econometric Society, an International Society for the Advancement of Economic Theory in its Relation to Statistics and Mathematics. Under the guidance of Professor Joseph Schumpeter, who was elected chairman of the organization meeting, a tentative constitution, prepared by Ragnar Frisch, Irving Fisher and Charles Roos, was revised and adopted. Professor Irving Fisher, of Yale University, was elected the first president of the new society. The organization meeting was attended by Ragnar Frisch, Harold Hotelling, Karl Menger, F. C. Mills, W. F. Ogburn, Oystein Ore, J. H. Rogers, C. F. Roos, R. C. Rorty, Joseph Schumpeter, Henry Schultz, W. A. Shewhart, Carl Snyder, I. Wedervang, Norbert Wiener and E. B. Wilson.

The American Statistical Association held its annual meeting on Monday, Tuesday and Wednesday, with 23 sessions. The topics covered ranged from the statistics of finance to those of unemployment, and from the field of psychology to that of engineering. Considerable stress was laid on methodology. Most of the sessions were well attended. Professor William F. Ogburn, of the University of Chicago, was elected president for the year 1931.

The 25th anniversary meeting of the American Sociological Society, held on Monday, Tuesday and Wednesday, had the largest attendance in the history of the organization, the registration reaching nearly 600, from all regions of the United States. This meeting was significant for the number of joint sessions, especially the one for presidential addresses, with the American Economic Association and with the American Political Science Association. There was one joint session with the American Association for Labor Legislation and three with the American Statistical Society. The section on rural sociology had a joint session with the American Farm Economic

Association on the subject "A Social and Economic Program for Sub-marginal Agricultural Areas." There was also a joint session of all the social science organizations on Social Science Abstracts. The central topic of the meeting, "Social Conflict," dominated both the general sessions of this society and those meetings of its sections. The presidential address, by Professor Howard W. Odum, of the University of North Carolina, was "Regional and Folk Conflict as a Field for Sociological Study." One general session of the society was given over to aspects of race and national conflict. The section on the family held a session on "Family Adjustment and Conflicts" and another on "Youth and Race in Family Conflict." The section on the community had a session on "Conflict and Integration in Community Organization," and another, jointly with the section on rural sociology, on "Inter- and Intra-Community Conflicts." The section on rural sociology had a session on "Social Conflicts in Rural Institutions"; the section on the sociology of religion, on "The Conflict Situations Affecting Religion"; the section on psychiatry, on "Relations of Psychological Conflict and Group Conflict"; the section on educational sociology, on "The Education of Cultural and Racial Minorities in the United States." A new feature this year was a session under the auspices of the section on the teaching of sociology, devoted to experimental sociology. This section also had a stimulating meeting on the teaching of introductory courses in sociology. At the annual dinner the topic was "Sociology in the next Twenty-five Years," with speakers representing the different social sciences. On the basis of a suggestion from the Social Science Research Council, a survey was authorized for the development of a plan of research by this society, and a committee for that project was named, with Professor Howard W. Odum as chairman. The membership dues were increased to $6.00, effective for the year 1933, and the special student membership rate was raised to $4.00, effective for the year 1931. Officers elected for 1931 are as follows: *President,* Emory S. Bogardus; *Vice-presidents,* Ellsworth Faris and R. D. McKenzie; *Secretary-treasurer,* Herbert Blumer, University of Chicago.

The Metric Association held its Weights and Measures luncheon on Monday, at which A. E. Kennelly and several others spoke informally. This was followed by a session for reading of papers concerning education, publicity, legislation, engineering and industry, in relation to the universal adoption of the metric system. The annual metric dinner occurred Monday evening. This meeting was unusually successful and all present felt that much had been accomplished.

The American Association of University Instructors in Accounting held its annual meeting on Monday and Tuesday. The subjects discussed fell into three groups: problems of training, analysis of costs of distribution and accounting theory. Among the papers presented were: "A Cost Approach to Elementary Accounting," by A. C. Littleton, University of Illinois; "Mathematics in Schools of Business," by W. S. Schlauch, New York University; "The Teaching of Ethics to Accounting Students," by H. J. Peisch, president of the American Society of Certified Public Accountants, and by J. C. Meyer, St. John's College; "Accounting in France during the Period of Inflation," by M. J. Wasserman, University of Illinois; "Depreciation and Appreciation," by H. W. Sweeney, of Price, Waterhouse and Company; "Technique of Distribution Cost Accounting," by H. C. Greer, University of Chicago; "Economic Theory and Problems of Valuation," by W. A. Paton, University of Michigan. At the annual dinner Monday evening Professor J. B. Canning, of Stanford University, was presented with the award of Beta Alpha Psi, the accounting fraternity, as the author of the best book on accounting published in the year ending May, 1930. The following officers were elected for the year 1931: R. A. Stevenson, *president;* James P. Adams, Howard C. Greer and G. H. Newlove, *vice-presidents;* E. L. Kohler, *editor;* and Chas. F. Schlatter, *secretary-treasurer.*

The American Farm Economic Association held its twenty-first annual meeting on Monday, Tuesday and Wednesday, attaining a new high mark in attendance and in interest. The following officers were elected for 1931: *President,* O. C. Stine; *vice-president,* F. P. Weaver; *secretary-treasurer,* W. I. Myers, Department of Agricultural Economics and Farm Management, Cornell University. H. E. Erdman, of the University of California, continues as editor of the *Journal of Farm Economics,* with S. H. Mendum, of the U. S. Bureau of Agricultural Economics, as assistant editor.

The sixteenth annual meeting of the National Association of Teachers of Marketing and Advertising was held on Monday and Tuesday. The attendance was the largest of any like meeting that has ever been held, there being from sixty to one hundred present at the various sessions. The program was divided into five divisions, each one with a specific topic. The first of these pertained to chain stores. A representative of the organized chains appeared on the program with a large operator in the voluntary chains. It was thought that the divergence of ideas would arouse some questions of interest, but the audience was disappointed in that the speakers complimented each other highly, and each registered full agreements

with the principles and practices presented by the other. One meeting was devoted to reports from members of this association who had been working in governmental investigation of business practices. Dr. W. R. White reviewed the work of the Federal Trade Commission and explained their material that was valuable for teachers. Dr. T. N. Beckman explained the details of the forthcoming reports of the Census of Distribution. A session devoted to an analysis of marketing costs was presented in connection with the American Association of University Instructors in Accounting. One session was given over to the consideration of Industrial Marketing, a new topic for such sessions. The last session was taken up with results of various research work undertaken by different instructors in marketing. Paul G. Converse, of the University of Illinois, was chosen president for 1931, and Hugh E. Agnew, of New York University, New York City, was reelected secretary-treasurer.

SECTION L (HISTORICAL AND PHILOLOGICAL SCIENCES) AND RELATED ORGANIZATIONS

(*Report from Joseph Mayer*)

Section L held two joint sessions, on Tuesday with the History of Science Society, in conjunction with the Committee on the Promotion of Chinese Studies, of the American Council of Learned Societies, and again on Wednesday with the History of Science Society, Section A (Mathematics) and Section D (Astronomy). The program had been arranged by a committee of 13, made up of representatives of the four groups, of which Dr. Edward H. Hume was chairman. The linguistic phase of Section L's activities was represented in the first day's sessions, but the linguistic societies themselves met elsewhere and developed excellent programs. The opening session of Section L was devoted to Chinese science and culture, Dr. Henry Crew presiding. Mr. Arthur Hummel, chief of the Oriental Division of the Library of Congress, spoke on "The Literature of Chinese Science." A summary of a paper by Dr. David Eugene Smith, on "The History of Chinese Mathematics," an exceedingly profound treatment, was read by Dr. Vera Sanford, of Western Reserve University. These two papers provoked an excellent and lively discussion. The third paper, which was to have dealt with the alchemy of China, was read by title only, Dr. Tenney L. Davis, who was to give it, being ill. Dr. Mary Louise Foster, of Smith College, History of Science fellow of the American Council of Learned Societies, spoke briefly on the "Alchemy of Spain," and her presentation was followed by further discussion. At the second session, which continued the program devoted to Chinese science and culture, with Mr. Hummel in the chair, Dr. K. K. Chen gave an illuminating account of the history of ephedrin in the Chinese pharmacopoeia. An energetic discussion followed, on Chinese culture, medicine and science, participated in by the chairman and by Dr. William H. Welch, Dr. Arnold C. Klebs, several Chinese students and others. This session brought to the fore some of the most fundamental questions of Chinese civilization. Dr. H. W. Tyler presided at the third session, which commemorated the tercentenary of the death of Johann Kepler (1571–1630). Dr. Kirk J. Struik discussed Kepler as a mathematician; Dr. W. Carl Rufus, Kepler as an astronomer; and Dr. E. H. Johnson, Kepler as a mystic. The address of the retiring vice-president of Section D, Dr. Harlow Shapley, was delivered at the beginning of the final session. Dr. Shapley's subject was "Galactic Exploration," illustrated with slides and presenting the latest available data on the constitution of remote stellar space. Dr. William H. Welch presided. A short account of the "Historical Instruments in the Adler Planetarium and Astronomical Museum, Chicago, Illinois," was presented by Dr. Philip Fox, who illustrated the planetarium's salient features with slides and exhibited a number of excellent specimens of early craftsmanship pertaining to astronomical instruments. Dr. Louis T. More gave an excellent sketch of Sir Isaac Newton, based upon hitherto unpublished accounts of Newton's personal life and characteristics. The final paper was given by Dr. Joseph Mayer on "Plans and Outlooks for Section L." Dr. Mayer pointed out that the integration of the American Association's activities is well furthered by a view of the sciences in their historical and philological aspects. Reference was made to the forthcoming summer meeting at Pasadena, for which the incoming chairman of Section L, Dr. William D. Munro, of the California Institute of Technology, plans to organize a program, and also to the next winter meeting, to be held at New Orleans. The following are the officers of the History of Science Society for 1931: William H. Welch, *president;* Berthold Laufer and J. Playfair McMurrich, *vice-presidents;* Frederick E. Brasch, *treasurer* and *corresponding secretary;* Joseph Mayer, *recording secretary.*

SECTION M (ENGINEERING)

(*Report from N. H. Heck*)

For the four sessions held by Section M on December 30 and 31 the programs with the exception of the first were largely arranged by local engineers under the leadership of James H. Herron. The first session dealt with engineering education especially after leaving the university. In his address as retiring vice-president, on Engineering Culture, H. F. Moore defined culture as the training, disciplining and refining

of the moral and intellectual nature and showed that this is incomplete without the engineer's idea of tolerance and his method of applied science. Thus the engineer is the smoother of the path for the development of refinement and morals.

W. E. Wickenden, discussing the education of the engineer after leaving the university, described the results obtained in various European systems. While the major part of education is received after leaving the university, much depends on the earlier education. Better unification of education is needed.

Arthur E. Morgan spoke on engineering education as it is related to the engineer's place in society, showing that one of the engineer's most important contributions to human welfare is to demonstrate that work can be changed from menial to dignified by the manner of its performance. An engineer's ability to do this depends on his education, for which increased liberalization and unification are needed. Engineering methods should be applied to our entire social structure. Concentration of power in the hands of a few may prove dangerous unless there is assurance that those in charge are culturally suited to such responsibility.

Edwin H. Colpitts told of recent developments in telephony by which the circuits used have wider ranges of the frequencies of the human voice, with consequent reduction of underlying noises. These developments depend on modifications of design and practice, including the employment of new materials and methods. E. P. Burrell, discussing the mechanics of the telescope, showed how improvements are continually being made in optics of the telescope, in the application of electricity to give the requisite motions and in devices for precise measurement. Modern telescopes are great engines of science which make modern astronomy possible. Wilbur J. Watson described and discussed the design of the Goodyear Zeppelin Dock at Akron, Ohio. Such structures as these have become so large that it is necessary to design with special regard to reduction of wind pressure, and special investigation into this subject was necessary. The stream-line features of the Akron dock made it necessary to design special doors and machinery for operating them and special methods for erecting the whole structure had to be devised. Temperature control and the storage of helium require special attention. Zay Jeffries discussed the plasticity of metals, one of the most important concerns of industrial practice. Most of the properties considered in metal testing are related to plasticity. The use of the microscope has shown fundamental relations between plasticity and crystalline structure and study of single crystals has proved especially profitable in this connection. Many surprising discoveries have come from the study of plasticity at very low temperatures. The relations between plasticity and electric conductivity are very complex. Studies on plastic deformation in metals should be valuable to physicists as a means of unlocking the secrets of the internal structure and properties of solids. Harold L. Thomas discussed salt penetration in a tidal river. He developed mathematically a method for determining the salinity grade lines under various conditions and was thereby able to fix the approximate position of certain salinity limits affecting the growth of oysters. Joseph W. Ellms discussed problems of sewage disposal and water purification in the Great Lakes. Sewage disposal and treatment of trade wastes are essential in the maintenance of sanitary water supplies. The influence of wind and of bottom contours on the concentration of pollution in the vicinity of water intakes was considered. There is need for correlation of the two problems of pure water and sewage disposal.

George W. Field raised the point that engineers, in the very effectiveness of their methods of river control, have overlooked some very important biological considerations, connected with the importance of maintaining the cycle of matter in water. This cycle runs from inorganic material such as salts and carbon dioxide, which facilitate plankton growth, through fish and other higher forms of life, and back again to inorganic matter, from which the cycle begins once more. It was emphasized that these considerations furnish cogent reasons for holding water back in suitable reservoirs, a procedure that aids also, as is often pointed out, in flood prevention.

SECTION N (MEDICAL SCIENCES)

(*Reports from C. W. M. Poynter and Benjamin Schwartz*)

The societies associated with Section N chose not to meet in Cleveland this year, but the section joined with the American Society of Tropical Medicine in a program on Tuesday afternoon. The interest of this session centered around a paper by R. R. Parker, of the U. S. Public Health Service. In a study of Rocky Mountain spotted fever he reported particularly on "Variations of Virulence of the Virus as Encountered in the Wood-tick, *Dermacentor Andersoni*," and found his conclusions agreeing with those of Dr. Ricketts. Although this section presented no program at Cleveland, the medical sciences were in no sense neglected, for the American Society of Parasitology had a very strong program in affiliation with Section F and many papers in the programs of Sections H and I were of particular interest in connection with medical research.

The twenty-sixth annual meeting of the American Society of Tropical Medicine was held in conjunction

with the American Society of Parasitologists. Of the eighteen papers read, eight were on protozoology and six of these were of direct interest to students of tropical medicine. Of the ten papers dealing with helminths, five were concerned with helminths parasitic in man. Two papers dealing with the dog hookworm, *Ancylostoma caninum*, were of unusual interest to students of tropical medicine. One of the most interesting papers presented before the joint sessions was a contribution by Dr. H. S. Wells entitled: "The Blood Sucking Activities of *Ancylostoma caninum*," presented partly by moving pictures. The following officers were elected for the ensuing year: *President*, Sidney K. Simon; *first vice-president*, Frank Smithies; *second vice-president*, E. L. Walker; *editor*, Chas. F. Craig; *councilor* for 5 years, Ernest C. Faust; *secretary-treasurer*, Benjamin Schwartz, U. S. Bureau of Animal Industry, Washington, D. C.; *assistant secretary*, Damaso de Rivas.

SECTION O (AGRICULTURE)

(*Reports from P. E. Brown, H. B. Tukey, F. S. Holmes, Fred Griffee, H. C. Moore and Paul Moore*)

On Monday afternoon Section O held a joint session with the Geneticists Interested in Agriculture and the American Society of Agronomy. The program consisted of a symposium on "The Application of Inbreeding and Improvement in Maize," arranged by Professor Fred Griffee, of the Maine Agricultural Experiment Station. On Tuesday morning and afternoon joint sessions were held with the American Society of Agronomy. Symposia on "Methods of Estimating Soil Deficiencies" and on "Methods of Fertilizer Application," arranged by R. M. Salter, of the Ohio Agricultural Experiment Station, were presented. The address at the annual dinner of Section O and related societies was given by M. F. Miller, of the University of Missouri, retiring vice-president for Section O, who spoke on "Erosion as a Factor in Soil Deterioration." A joint session with the Ecological Society of America was held on Thursday afternoon, the program consisting of a symposium on "Environmental Units."

The twenty-seventh annual meeting of the American Society for Horticultural Science, held on Monday, Tuesday and Wednesday, was the most successful in attendance and in quality and number of papers in the history of the organization. With 154 papers on the program it was necessary to hold eleven regular sessions, besides an evening banquet and an evening round table for extension workers. The trend in horticultural research is shown by one session devoted to stocks and propagation, one to small fruits, two to floriculture and ornamental horticulture, two to vegetable crops and five to general pomology. The principal changes are in the direction of rapid scientific development in vegetable crops, propagation, floriculture and ornamental horticulture. Interest in physiological problems continues to dominate, as indicated by a very successful joint session with the American Society of Plant Physiologists, though increase in morphological and cytological papers is also significant. The wide interests of horticultural science and the demands it makes upon allied fields in the solving of its problems is shown by papers which dealt in part with animals. Papers upon economic problems appeared for the first time, and a resolution was adopted pointing out the desirability of inviting to the next meeting papers upon economic studies in horticultural fields. The newly elected president of this society is Professor T. H. McHatton, of Georgia.

The Association of Official Seed Analysts of North America held its annual meeting on Wednesday, Thursday and Friday, with attendance larger than usual and with representatives from Canada and from every section of the United States. The secretary reported that there were fifty member laboratories in the organization. Officers elected for the coming year are: *President*, C. W. Leggatt; *vice-president*, F. H. Hillman; *secretary-treasurer*, F. S. Holmes, College Park, Md. Standing committee reports were unusually comprehensive. It was decided that this association would undertake the preparation of a handbook on seed testing to supplement the rules for seed testing adopted at Ithaca in 1926. The International Seed Testing Congress, which meets every three years, will be invited to meet in the United States in 1934. The number of papers presented at Cleveland was larger than ever before. The outstanding feature of the meeting was a symposium on "Variations among Purity Analyses and Germination Tests, and Tolerances," which occupied an entire day. The papers presented at the meeting will appear in the *Proceedings of the Association of Official Seed Analysts of North America*.

The seventeenth annual meeting of the Potato Association of America was held on Tuesday and Wednesday. Twenty-eight papers were presented, on recent experiments in potato-disease control, seed selection, spraying, tillage, etc. One half-day session was devoted to potato breeding and selection. Special impetus has been given to this phase of work in recent years by the Office of Horticultural Investigations of the U. S. Department of Agriculture and several state experiment stations. The Seed Potato Certification Committee recommended more uniformity in certification standards as applied to bin and carload inspections, and a resolution was adopted to the effect that the Potato Association is to sponsor the organi-

zation of a national seed-potato certification council, composed of certification officials representing the states conducting seed-potato certification. This council is to give special attention to the distribution of certified seed and to marketing problems.

On Monday morning the Geneticists Interested in Agriculture met with the Genetics Sections, at a symposium on "Inbreeding and Its Application to Improvement in Plants and Animals." The paper presented by F. A. Krantz showed clearly the possible value of selection in inbred lines followed by crossing as a means of varietal improvement in the potato and other similarly propagated plants. W. F. Dove presented data from studies in poultry, suggesting the value of breeding for specific characters and using matings of various degrees of relationship. On Monday afternoon there was a joint session with the American Society of Agronomy, with a symposium on the "Application of Inbreeding to Improvement in Maize." Evidence was adduced to show the value of the "pure line method" in developing disease resistance. The results from studies on convergent improvement suggest that this method offers possibilities for raising the yielding ability of F_1 crosses between selfed lines of corn. It was also shown that selfed lines varied in prepotency when used as sires on commercial varieties of maize. J. L. Lush, Iowa State College, Ames, Iowa, was elected secretary for the ensuing year.

The Crop Protection Institute held its annual dinner meeting on Monday. Professor W. C. O'Kane, chairman of the board of governors, stated that, in the ten years of the institute's life, it had administered nearly half a million dollars for various industrial organizations in research projects directed by the institute. Taken into account also must be the additional funds and labor of the stations and their men in this fine cooperative plan. Work has been conducted in more than a dozen different states and this year has extended to the Pacific coast. Projects have been carried on at Berkeley, California, and at Pullman, Washington. These were studies on the use of oils against codling moth. About a year ago this institute undertook for the Research Corporation a study of emulsions of coconut oil, which is to be continued. Paul Moore, secretary-treasurer, reported receipts of $54,025.30 in the fiscal year just closed and expenditures in the same period of $55,517.44. There was in hand $33,737.13. It was again emphasized that the Crop Protection Institute needs endowment, the income of which might be used to carry on work for which funds can not be secured from industry.

SECTION Q (EDUCATION)

(Report from W. L. Uhl)

The sessions of Section Q were on Monday, Tuesday and Wednesday. The address of the retiring vice-president for the section, Professor Frank N. Freeman, of the University of Chicago, was given on Tuesday evening at the dinner of the Section, Phi Delta Kappa and Kappa Delta Pi. Professor Freeman contrasted scientific and philosophical methods in education, and urged students of education to abandon the speculative methods of philosophers and to rely instead upon that which has been discovered and interpreted by logical procedures. There were five sessions for the reading of papers, each devoted to a single topic. Some of the papers are mentioned here. In the session on experimental study of elementary education Clifford Woody reported on an inventory test of arithmetical backgrounds for the primary grades. At the time formal education is introduced children have a considerable ability in counting and in reading numbers, in recognizing coins and knowing their value, in telling time, in recognizing and understanding simple units of measurement, and in the fundamental processes in addition and subtraction of simple combinations. The Detroit individualization experiment was reported upon by Wendell Vreeland. Six plans have been followed, with different degrees of individualization. Results from two years were given, in terms of the test scores of 13,000 pupils. The program of experimental studies of secondary education included a report upon the grade placement of mathematical concepts, by C. H. Butler. Inventory tests show that in grades seven to nine pupil's wasting of concepts often varies as much within a given grade as between different grades. Two papers, those of W. J. Grinstead and B. C. Gruenberg, showed the value of using pupils's errors in planning both regular and remedial work. S. L. Eby showed by means of word counts that modern history text-books carry a heavier vocabulary burden than the character of the facts discussed actually requires. Gordon Hendrickson discussed the relationship of interests to success in trade training. The measurement of effects of certain motion pictures in physics was treated by R. K. Watkins, whose data showed that motion pictures are neither inferior nor superior to other possible devices. Among the papers on collegiate education was a report by Frank L. Wright, from which it appears that some teacher-training institutions still depend too largely upon training students in teaching, with too little attention given to the subject-matter that is to be taught. This was corroborated by S. R. Powers, who discussed

standards for providing "respectable scholarship" for teachers of science. V. H. Noll showed that, in spite of possible fatigue and without respect to possible after-effects, college students do better work in the third hour of a continuous three-hour test than in the first hour. W. J. Osburn reported upon a continuation of his earlier investigation of overlappings in science teaching. It appears that time is ordinarily wasted in reteaching either what pupils already know or what they could recall by means of short reviews. It was estimated that one of the six semesters spent upon biology, physics and chemistry might be saved. The program of papers on social education included two reports on methodology; one of these, by Miss Ruth Arrington, treated the social implications of undirected child activity, and the other, by F. M. Thrasher, described the technique of studying the community factors that determine child behavior. F. F. Powers discussed the relation of intelligence and personality traits to false beliefs, showing that both introversion and the tendency to be influenced by false beliefs seem to result largely from early training. It was added, however, that bright pupils probably learn more erroneous statements while very young than dull pupils do. H. Meltzner, reporting upon the relation of the forgetting of unpleasant experiences to intelligence, arrived at similar conclusions. The Shields age scale for the measurement of moral judgment was discussed by E. A. Lincoln, who considered this scale to be about as satisfactory now as the Binet-Simon scale was before the American revisions of it. At the session on research in supervision S. A. Courtis presented results of an attempt to measure efficiency in terms of increase in pupil achievement. A. S. Barr dealt with the validation of tests and rating scales for the measurement of teaching ability. Papers on the organization of administration and supervision were presented by W. G. Brink, E. O. Melby and S. A. Hamrin. F. L. David reported upon a study of the personnel of recent curriculum committees in thirty-four representative school systems.

ORGANIZATIONS RELATED TO ALL SECTIONS

(*Reports from Edward Ellery, Joseph Mayer, Ellen Eddy Shaw, R. W. Babcock and Julia T. Colpitts*)

The executive committee of the Society of the Sigma Xi met Tuesday afternoon and transacted business as follows: informal petitions for chapter charters were considered from nine institutions; the committee on award of research grants will hereafter be appointed by the president, on nomination by the chairman of the retiring committee and the national secretary; installing officers for the installation of new chapters will be the national president and national secretary, or some substitutes appointed by the national president. The thirty-first annual convention of the society opened at 4 o'clock. Chapter charters were voted to the University of Pittsburgh and Harvard University; Rodney H. True, of the University of Pennsylvania, was elected to the executive committee, to serve five years; Frederick B. Utley, of Pittsburgh, was chosen as member of the Alumni Committee to serve five years; the executive committee was asked to consider ways in which this society might develop research talent at institutions that are without chapters; tentative plans for the semi-centennial of the society, to be held in 1936, were reported. The annual Sigma Xi dinner was held Tuesday evening, in conjunction with the American Physical Society, with an attendance of 300. This was followed by the ninth annual Sigma Xi address, under the joint auspices of the American Association and Sigma Xi, by Dr. C. E. K. Mees, on "The Science of Photography."

The seventeenth annual meeting of the American Association of University Professors was held on December 27 and 29, with an attendance of about 150 persons, representing 100 chapters. W. B. Munro presided. On the Sunday which intervened in the meeting period the members were addressed by President R. E. Vinson, of Western Reserve University, and Director A. C. Ellis, of Cleveland College. Speakers at the Saturday luncheon and the annual dinner were, respectively, President Vinson and President E. H. Wilkins, of Oberlin College, and those at the Monday luncheon were President W. E. Wickenden, of the Case School of Applied Science, and Professor W. C. Mitchell, of the Social Science Research Council. President Wickenden described the recently established working agreement between the Case School and Western Reserve University, and Professor Mitchell outlined the program of the Social Science Research Council. The constitution was amended on Monday, making it impossible for a person to be a junior member for more than five years and increasing the dues to $4.00 for active members. Officers for 1931 are: W. B. Munro, *president;* Hardin Craig and J. S. Guy, *vice-presidents;* H. W. Tyler, *general secretary,* Joseph Mayer, *executive secretary and treasurer.*

The problem of methods designed to secure academic freedom and tenure was referred to the Council and Committee A for further consideration. The following statement of principle was adopted: "No university professor who receives a fee from any person or association interested in public discussion or in testimony respecting a particular question of public importance should take part in such discussion with-

out making public the fact that he receives such compensation and making public the name of the person or association paying him the said compensation."

Upon recommendation of the council, the following resolution was adopted:

WHEREAS, during June and July, 1930, wholesale dismissals and demotions were made at the University of Mississippi, the Agricultural and Mechanical College, the State College for Women, and the State Teachers College, all of the State of Mississippi; and

WHEREAS, these dismissals and demotions were made apparently for political reasons, without the consideration of the welfare of the students affected, and, so far as we are informed, with no notice to those dismissed or demoted, as a result of which much damage has been done to the cause of education in that state as well as great injustice to those dismissed or demoted; and

WHEREAS, the American Association of University Professors believes that the welfare of the cause of education is greatly endangered by political interference of this type; therefore, be it

Resolved, that the American Association of University Professors concur in the condemnation of this action of the authorities of the State of Mississippi as expressed by the Association of State Universities, the Association of Medical Colleges, the Southern Association of Colleges and Secondary Schools, and other bodies; and further, be it

Resolved, that the above-mentioned state institutions of the State of Mississippi be and hereby are dropped from the eligible list of this Association until such time as the Administration of educational affairs in the State of Mississippi has been restored to a status acceptable to this Association.

Some of those attending the meeting of the Association of University Professors had apparently not been informed about the proper use of the railway-certificate arrangement made by the American Association for the Advancement of Science, whose registration offices endorsed thirty-five railway certificates of persons who attended the University Professors' meeting but would not register with the association. This special setting aside of the rules was authorized by the permanent secretary only because of an apparent misunderstanding, but it is not a precedent and should not be allowed to occur at future meetings. It should be clearly understood that all who use railway certificates in the name of the "American Association for the Advancement of Science and Associated Organizations" are to register with the association in order to secure endorsement (and subsequent validation) of their certificates. Because the American Association has a registration fee it is obviously unfair to make any exceptions to the rule about endorsement and validation of certificates.

The American Nature Study Society held regular sessions on Tuesday, Wednesday and Friday and met with Section Q (Education) on Wednesday morning. The meeting was opened with an address of welcome by President Bertha Chapman Cady. A paper was read on the "Activity Program—Kindergarten and Primary Grades in Elementary Science," by Ruth Palmer, of the Doan School, Cleveland, Ohio. At the joint session there were three papers of particular interest to nature study: "Humanizing Biology," by William Gould Vinal, of the School of Education, Cleveland, Ohio; "Methods in Doan School Elementary Science Curriculum Center," by Mary Melrose, general supervisor of elementary schools, Cleveland; and "The School Gardens of New York City," by Van Evrie Kilpatrick, director of nature-garden work, New York, N. Y. On Wednesday afternoon, among other speakers, V. W. Jackson gave a demonstration of motion pictures used as "stills," a very interesting use of the motion-picture reel. A. F. Satterthwait, director of the Webster Groves (Missouri) Branch of this society, spoke of activities and opportunities in branch formation, an important phase of nature-study work. Anna Clark Jones spoke, on invitation, about nature study abroad, particularly in the School for Young Naturalists, in Moscow. A. F. Satterthwait was elected president of the organization for the coming year, and Jennie E. Hall, supervisor of Nature Study in Minneapolis, was elected secretary-treasurer.

The Gamma Alpha Graduate Scientific Fraternity held its annual council meeting and convention on Tuesday and Wednesday. The principal work of the convention was the adoption of a revised constitution and by-laws, which are in keeping with the general spirit of progress within the fraternity. Approximately sixty men were present at the reunion breakfast. The officers for the following year are: *President,* Rodney W. Babcock; *secretary,* H. R. Nelson, Cornell University, Ithaca, N. Y.; *treasurer,* Carl Schmidt; *editor,* Carlton Scofield; *recorder,* D. S. Welch.

Sigma Delta Epsilon, Graduate Women's Scientific Fraternity, held its ninth annual convention following a breakfast on Wednesday morning. Forty-three members were present, with representation from every one of the eleven chapters. The national officers elected for 1931 are: *President,* Leva B. Walker; *vice-presidents,* Mrs. Dorothy Murdock and Ruth I. Walker; *secretary,* Katherine Knowlton; *treasurer,* Laura Florence. On Tuesday morning this organization arranged a breakfast to which all women in science were invited. Sixty-six members and guests were present representing about thirty institutions. Dr. Adele M. Grant gave a short history of the organization, and Dr. Mary E. Collett gave an address on "Metabolism and Circulation in Women."

SCIENCE

VOL. LXXIII FRIDAY, FEBRUARY 13, 1931 No. 1885

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SOME PRESENT-DAY PROBLEMS OF ZOOLOGY TEACHING[1]

By Professor WILLIAM A. RILEY

UNIVERSITY OF MINNESOTA

IN coming before you to-night I wish first to express my appreciation of the high honor of being chosen to serve as vice-president of the section set aside for the zoologists in this great organization of American men of science.

It happens that, owing to the absence of our vice-president of last year, there has been introduced a new policy, that of asking the newcomer to give the annual address. When the readjustment is being made both the speaker and his audience are aware of some of the advantages of the older policy.

My predecessors in Section F have dealt with a widely varied list of topics. Some have discussed in a trenchant manner that special field of research which they have personally cultivated, others have dealt with more general problems or have surveyed the accomplishments of recent years in some particular field of zoology.

There is another aspect which is a very live problem in educational work, but which we are inclined to give scant attention. I refer to the ever-growing complaint regarding the teaching of the sciences. Perhaps its consideration might better be left to other groups, but I have had the temerity to choose for to-night this general subject and I shall ask your indulgence while I speak of "Some Present-day Problems of Zoology Teaching." Let me hasten to explain that I do not intend to suggest some new method of examinations, nor of mid-term or weekly or daily reports. Neither do I pose as an educational expert—my dis-

[1] Address of the vice-president and chairman of Section F—Zoology, American Association for the Advancement of Science, Cleveland, December 31, 1930.

cussion is frankly based by my interests in zoology and in the propagation of zoological interests in others.

Wherever zoologists congregate there is stress, and rightly, on the importance of research. It is the mainspring of any science, without which progress is impossible. Genuine interest in it is one of the most valuable aids to successful teaching in spite of insistent charges to the contrary.

Nevertheless, it is not the only means by which a science advances. Bacon, three centuries ago, in his classic volume "The Advancement of Learning," discussed not only the methods by which knowledge is to be gained but also the importance of making it intelligible to society at large. Indeed, our American Association for the Advancement of Science recognizes this popularization of science as one of its functions and is devoting an ever-increasing amount of attention to the problem.

Our interests, then, are dual, but there would seem little necessity of emphasizing before this group the importance of research. Your very presence at these Convocation Week meetings testifies to your interest it it.

Foremost among all the agencies for bringing about the diffusion of knowledge is classroom instruction. The entire group here present is concerned directly or indirectly with the teaching of zoology, however varied the proportion of time available for individual investigations. As teachers or as researchers we shall be more and more affected by some of the present-day trends in our colleges and universities. Their name is legion, and they are already doing much to determine the type of students in our classes and in our graduate schools. Perhaps some of you will not agree when I select as the most important three affecting our work those of (1) the changed view-point regarding the function of the university; (2) the position of laboratory work, and (3) those affecting departmental curricula. In discussing them, I shall treat of what I believe to be general rather than regional or institutional trends.

The one most vitally affecting our work and that on which the others are ultimately dependent is the remarkable shift which has come in the conception of the aims and function of the university. There have been and are to-day many attempts to define this function, but we may class them as (1) those which conceive of the university as the capstone of the educational system, obedient to public demands, and accepting any graduate of the secondary schools of the state, and (2) those which conceive of the university as a leader in educational ideals, accepting students who have demonstrated their ability for more advanced work, and not concerned with what Dr. Keppel has called the "period of extended infancy."

It is needless to say that these are diametrically opposed view-points and, however great the efforts on the part of those who are struggling to reconcile them, one or the other ultimately must give way. There will be lone schools which will stand against the current for a considerable period, but so inextricably are educational institutions interrelated that none can escape the influence of the dominant conception.

There can be no doubt that even to-day that dominant conception has become one of an unbroken system from the kindergarten to the graduate school, and already there are demands that its requirements and standards be adjusted to accommodate the hordes who must have a doctor's degree in order to obtain or to hold a position in our colleges. In many places the slogan is "Whosoever will may come and partake freely of the Pierian spring," and coupled with it there is not infrequently the implied suggestion within the institution that he should not be required to drink deeply, since the object of the universities is to "prepare the student for life,"[2] rather than to make a scholar of him. A recent writer has expressed clearly his own and a common opinion when he says, "The outside citizens are the ultimate deciders of school policies, they hold the purse strings, they own the schools. Educators are their employees."

I would not by any means imply that this policy is motivating all our state universities. There are certain notable exceptions and few, if any, have yielded altogether. On the other hand, I believe that it is a fair statement of the trend and that long before the swing of the pendulum is reversed, our endowed institutions, too, will be radically affected by it. Indeed, they are by no means immune to-day.

Many are the attempts to stem the tide. Probably the most in favor at present is the establishment of junior colleges which will care for not only those students who do not expect to continue beyond two years but also for those from the neighborhood who expect to go on to completion of the college course. Already there is ample reason to see that this will only double the difficulties. In general, the equipment, library facilities and teaching staff of these institutions are in nowise comparable to those of the universities. They are more lenient in accepting their students. The result is that there will exist the same gulf between their courses and those of the senior colleges that is now the source of complaint from the high schools. In the one as in the other case the proposed

[2] This slogan, so widely used, does nothing in the way of defining what is the best preparation our universities can offer. All conflicting viewpoints claim its guidance.

remedy will be that of lowering the requirements of the advanced work.

The effects of the movement are all-pervasive. The graduate schools are accepting more and more of non-resident study, or Saturday afternoon, evening and correspondence courses. This is despite the fact that one of the most valuable features of graduate study is the contact with seminars, library facilities and, presumably, the atmosphere of research. The requirements of two modern languages are being vigorously attacked and in various quarters the substitution of educational statistics for one or even both of the languages is a matter of routine. The largest of our schools of education has frankly waived the rule that the Ph.D. thesis must represent an original contribution.

I am not here discussing whether these changes throughout our whole university system are desirable or not—I am merely pointing out that they are rapidly coming about. Inevitably they affect our science courses and the rôle which our departments of zoology can play in the system of education. Are, first, our beginning courses and then our intermediate, and, finally, the advanced courses to become merely informational in nature, supplanting the old-time Chautauqua lectures, or are they to adhere to an ideal of giving all their students the best possible training under the limitations which exist and of developing and stimulating a scholarly attitude towards the subject?

Despite the antagonisms and, later, the evasions which prevailed in the latter part of the nineteenth century, it is no longer necessary for the proponents of science teaching to battle for recognition of their field by the schools and colleges. Some of the discussions of that period and particularly the essays and addresses of Huxley are well worth reading. It is as true to-day as it was in 1869 that "if the great benefits of scientific training are sought, it is essential that such training should be real; that is to say, that the mind of the scholar should be brought into direct relation with fact, that he should not merely be told a thing but made to see by the use of his own intellect and ability that the thing is so, and no otherwise."

Gradually the educational world came to accept the idea that the study of science deserved a place with the classics in the curriculum because it did bring the mind directly into contact with fact and strove to train it in the acquisition of first-hand knowledge. So fully has it been accepted that it is now the classics which are on the defensive and in all too many places are struggling for existence.

The driving force of the movement, then, was the stress on the value of the laboratory method. "If scientific education is to be dealt with as mere bookwork it will be better not to attempt it but to stick to the Latin grammar which makes no pretense at anything but bookwork" was Huxley's warning and in this country it was matched by Agassiz's "Study nature, not books"—a slogan which was not directed at books but at servile dependence upon them.

In those benighted days it had not been discovered that "the most evil influence in education" was the scholar and it was natural that the attitude of leaders in the colleges and universities should be manifested in the secondary school teaching of science. It must be admitted that the result was not always wholesome, though there is ample room for question as to whether the present-day tendency in the other direction affords a sound substitute.

Be that as it may, it is true that the more progressive high schools attempted to duplicate in so far as their finances permitted the equipment and the methods of the college laboratory. To be sure, there came from both college and secondary schools vigorous protests against the cost of such instruction. Years ago Youmans admitted that "of the two classes that may be taken generally as most ignorant of the science of their business—cooks and congressmen—it will cost at least ten times more properly to educate the former than the latter."

Still more serious was the fact that at times the newly created B.S. went into these schools with little idea other than to duplicate as nearly as possible the course which he had taken in college. Often he had little conception as to how to proceed until he had gotten an equipment of microscopes, sea urchins, dogfish, Grantia and starfish. The results were likely to be disastrous and the zoological departments of the colleges were to a considerable degree responsible for these misfits. As long as the majority of college departments of zoology were themselves ignoring the wealth of material in the local fauna it was too much to expect that their product would realize the potentialities of his environs or have any particular interest in the population of its fields and streams. As long as the college departments were insulated from the work of the secondary schools it is small wonder that their graduates had no idea of the problems which they would face if they were called upon to teach in these schools.

This situation, coupled with the acute problems arising from the crowding of our high schools, attracted an ever-increasing amount of attention on the part of those responsible for the development and administration of secondary education. To-day the validity of the claims for laboratory instruction is being challenged sharply and more and more there

is coming about a reversion to text-book instruction or to lectures—the incipient text-books—supplemented in varying degree by classroom demonstrations. This movement is rapidly extending to our colleges and universities where it is manifested in the increasing demand for survey courses in which the laboratory method plays no part. Forgotten are the arguments which opened up the curricula to the biological sciences. Must we consider this a retrogression? Perhaps they *should* be forgotten, for there is no more excuse for a static education than there is for a static science.

A considerable factor in the decreasing emphasis on laboratory work is unquestionably the economic one. The faculty of making a virtue of necessity is one of the beneficent anodynes afforded mortals. If it is found that it is physically impossible to provide space and equipment for the hordes of incoming students, and if the motivating educational philosophy demands that they all be welcomed, then it is to be expected that expensive types of instruction would be subject to particular scrutiny, and substitutes receive at least a very sympathetic consideration.

It would be unfair and superficial to assume that the question of expense is the only one involved or even, in most cases, that it is the primary one.

There never has been any agreement as to just the proportions in which lecture, demonstration, charts and lantern-slides and laboratory work should be mixed. We may individually have very definite opinions, but we do not have any satisfactory methods of tasting the concoction while it is stewing. We may believe firmly in a rigid application of the methods of Agassiz, but no advocate of large classes has yet offered a clue as to how such technique can be followed under the conditions which face us. Is there no approach to the problem other than that of observation and opinion?

The present century has seen the introduction of methods of psychological research which are influencing profoundly and will continue to influence our systems of education. They have emanated from a small group of thoroughly trained investigators, capable of self-criticism and motivated, as every scientist must be, by a desire to learn the truth and as nearly as possible the whole truth about their problems. They were great teachers, untrammeled by standardized methods, and capable of enthusing and stimulating the students with whom they come in contact.

Unfortunately, among their followers are not only many serious and careful workers but also zealots with scant preparation, whose chief efforts apparently have been devoted to criticism of our colleges and to attempting to carry over into the universities the methods and ideals of the public schools. The result has been that, instead of contributing to the improvement of teaching in the colleges through work that wins respect by its scholarly approach and tempered criticism, they have often antagonized, and have failed to receive credit for whatever of merit they may have presented. The constant iteration and reiteration of the claim that the worst teaching in the country is college teaching is an illustration of a type of mischievous and irresponsible statement which is doing nothing to better conditions. Neither is the assumption that there has not been in the past any constructive thought devoted to efficient presentation of the subject-matter of the sciences or that the whole situation can be revolutionized by a statistical study of the results of examinations.

However, none of this excuses a teacher of zoology from attempting to keep in touch with the real research work which is being done on methods of presenting his subject, or from constantly checking over and attempting to improve his work. When he reaches the stage of having no interest in such matters it would be better for himself and his institution if he could be retired.

If he be scientifically trained, as fortunately may still be assumed, he will not accept at face value every piece of experimental work which finds its way into the literature. Neither will he be justified in treating his students always as subjects for investigation. There are a few groups of peoples which have been more or less tacitly regarded as legitimate experimental material—condemned criminals, subject nations and men under rigid military discipline. To these we are now adding the students of our schools and colleges, but the teacher who regards his students in that light is no more able to do his best for them than is the doctor whose first concern in meeting his patients is the study of the action of some particular drug. There may be exaggeration and a note of irritation in the charge by a recent writer that "teachers instead of teaching are everywhere fetching and carrying for the investigators," but it is certainly normally the case that " in just the degree in which a teacher is an inspiration to his pupils he is unfitted as a collector of statistics."

To the present there has not been developed any adequate measure of the effects of laboratory work on the student. It is comparatively easy to measure the retention of facts in sufficient degree to pass examination, but no believer in laboratory work considers that its chief value is as an adjunct to the cramming process. To be sure it is quite as *passé* to con-

sider that habits of accuracy, sincerity and respect for scientific evidence could be inculcated through laboratory work as that any subject possesses abstract disciplinary value. I would point out, though, that Thorndike himself never took the extreme view which is often attributed to him but that he definitely taught that the results of training could be transferred and that even where this was much less than had previously been assumed it had a very significant value. Reference to "intangible effects" are anathema to many of the enthusiastic devotees of the new research and yet every earnest teacher knows that they can not be ignored. Their number will be reduced as the technique of investigation becomes refined, but we must agree with Archibald Rutledge that "it is exceedingly doubtful whether that mysterious whole which we term personality will ever yield to investigators, however patient, honest and meticulous in their searchings they may be." It is on this personality that the intangibles become inextricably impressed.

I have listed as a third topic certain trends in the setting up of departmental curricula. In not a few cases these are the antithesis of what I have already discussed. Perhaps they are defense reactions, more or less consciously developed. In any event they will affect in no little degree the future development of our subject.

In our large institutions of to-day departments are allowed a very considerable latitude in the fixing of the requirements for their major students, however much their introductory courses are shaped by demands for popularization. Apart from the fact that the elementary courses in high school and college have already done much to fix the student's ideals of work and his thought processes, this still permits of the development of a well-rounded departmental course for students who are particularly interested in zoological work. It is of the utmost importance that the responsibility be accepted and administered in such manner as to develop the student to the maximum degree.

Of the various ways in which this development may be hindered a not uncommon one is too great a stress upon some narrow field in which the teacher is interested. It is of great advantage to the young student to be associated with an investigator in the study of a section of a problem, if it is not at the expense of a breadth of preparation which will be essential to the success of that student when he leaves the university. There are cases in which a teacher who owes much of his success to his own broad training overlooks the fact that some of his efficient students are little more than expert technicians.

Again, there may be the mistake of setting up a rigid curriculum which either does not allow for sufficient recognition of the aptitudes and natural interests of the student or, on the other hand, so monopolizes his time as to make it impossible for him to take advantage of and learn to appreciate the cultural opportunities afforded by work outside of his specialty.

In all ages the greatest teachers have been concerned with the development of the individuality of the student. There is general agreement to-day that this is the highest goal of education, however much we hamper it by some of our practices.

The field of zoology is a broad one and capable of profiting greatly from the work of students of widely varying tastes and interests. The best development of the student demands that we treat him as an individual—a problem much easier of solution in the limited confines of a department than in the institutions as a whole. To set up a uniform requirement for all who are attracted to the field is no more justifiable than was the adherence to the single universal curriculum of the old-time college. This discarded policy was supported by arguments which are strictly analogous to those used in favor of rigid departmental requirements.

The monopolizing of the student's time, at the expense of his fuller development, is another danger to be avoided in this process of setting up an ideal program for making a zoologist. As soon as we start out on the theory that "surely anybody who is going to major in zoology should have . . ." we find that we have filled his undergraduate years with chemistry, zoology, botany, physics, mathematics, foreign languages, geology and special courses in zoology. Where have we allowed for the student's development of any appreciation of the literature of these foreign languages or of our own language, where for philosophy, history, sociology or the other fields of knowledge which, if not opened up in the undergraduate days, are very probably destined to be forever closed to him? Is there not a danger of unconsciously adopting a trade-school ideal rather than supporting that of *education* in contrast to mere *instruction?*

The science of zoology has made unparalleled advances during the past century. We owe it to the present to make the knowledge already gained more generally available and to stimulate the workers of the next generation to still greater achievements. If it seems, sometimes, that our educational systems are milling around in a confusing conflict of ideals and aims—of readiness to size upon anything new, and of conservatism—let us at least hope that there is a spiral upward movement and let us do our share to make it manifest in our chosen field.

PLANES OF LATERAL CORRASION

By Professor DOUGLAS JOHNSON

COLUMBIA UNIVERSITY

NEARLY thirty years ago the writer studied in central New Mexico a very perfect erosion plane surrounding and sloping gently away from the Cerrillos, Ortiz, Sandia and Santa Fé Mountains. Near the ranges the plane usually was cut in igneous or other resistant rock of the mountain core; farther out it neatly bevelled the upturned edges of sandstones, limestones and shales which had been steeply tilted by the mountain uplifts. Close to the ranges the erosion plane was masked by a relatively thin cover of alluvial gravels, or was fully exposed to view as a smooth rock floor, sometimes well preserved, sometimes dissected to give a belt of low foothills, having remarkably accordant summits. Away from the mountains the alluvial cover thickened, and only the fortunate circumstance that later erosion had deeply trenched the country made it possible to observe the depth of the alluvium and the perfection of the buried erosion surface.

The results of the writer's studies were published in 1903–1904 in a medium which has quite naturally escaped the attention of later students of this type of erosion surface.[1] While recognizing that the far-spreading erosion plane of the Cerrillos region bore some resemblance to peneplanes described in the literature, I hesitated to apply this term to a form which was truly plane over broad areas; nor could I ascribe its development to the normal processes of peneplanation as then understood. Neither did it seem reasonable to credit sheet-flood erosion with the initial development of such a surface, although this process might be responsible for further erosion of a plane once formed. The most helpful suggestion came from a perusal of Gilbert's "Geology of the Henry Mountains." That fertile thinker invoked the lateral corrasion of streams to explain the "planation" of tilted sedimentaries in such manner as to produce inclined erosion surfaces identical in character with those of the Cerrillos Hills and adjacent areas. The writer therefore stated that "the phenomena are essentially those described by Gilbert as the results of 'planation'" and added in another connection that "sheet-flood erosion was doubtless an important factor in this process of 'planation.'"

In later years increasing attention has been directed to inclined erosion planes surrounding mountain masses in arid regions. Lawson's critical analysis of the "suballuvial bench" and related forms, and Bryan's excellent studies of "pediments" have been especially valuable in spreading a knowledge of these forms and in provoking further study of their origin. Compared with these and other able studies my own early account now appears to me what it really is—the crude and incomplete discussion by an inexperienced student of a novel problem which he did not fully understand. And yet my brief and imperfect account presents two features which perhaps entitle it to some consideration: It describes (although too briefly) the most beautiful examples of rock pediments or suballuvial benches ever seen by me in the field or, so far as I can judge from the printed page, yet pictured in the literature; and, unlike the later discussions referred to, it follows Gilbert in ascribing to lateral corrasion by streams the dominant rôle in sculpturing planes of this type.

I have followed the growing literature on the subject of planation surfaces with some care, and with an ever-deepening conviction that Gilbert's early contribution to the subject has failed to receive the attention it deserves. The failure is due, perhaps, to the fact that Gilbert never elaborated his suggestion to the point where its full significance became manifest. For many years I have been emphasizing to my students what have seemed to me certain superiorities of the Gilbertian hypothesis; and some of these students have followed Gilbert in their published work.[2] Otherwise I have found but one authority who seems to have shared the conviction that Gilbert has most correctly explained the process by which piedmont erosion planes are formed. Unknown to the writer Eliot Blackwelder, as a result of his desert studies, independently reached the same opinion, a fact brought to my attention in personal conversation with him last spring.

In the years since my first introduction to such planes in the Cerrillos Hills, I have from time to time tried to analyze Gilbert's idea with the aid of accumulating knowledge concerning these planes, to develop the theory more fully than did that author, and to deduce its reasonable consequences to the point where we might test the validity of the theory by critical field evidence. By 1929 this deductive study

[1] Douglas Johnson, "Geology of the Cerrillos Hills, New Mexico." *Columbia University School of Mines Quarterly*, xxiv, 173–246, 303–350, 456–500, 1903; xxv, 69–98, 1904.

[2] See, for example, the discussions of lateral planation by F. K. Morris in Berkey and Morris's "Geology of Mongolia," Natural History of Central Asia, Vol. II, 475 pp., New York, 1927.

had reached the point where it seemed desirable to examine in the field certain well-developed piedmont erosion surfaces in order to compare the availability of the several hypotheses advanced by Gilbert, Lawson, Bryan, and others. The writer was granted a year's leave of absence from academic duties at Columbia University for the purpose of making this and certain other studies related, directly or indirectly, to the broader problem of changes in continental elevation. Among the regions visited were South Africa, New Zealand, and the southwestern United States including the Sacaton Mountains and Cerrillos Hills districts, in all of which areas important evidence regarding the nature and origin of piedmont erosion planes was secured. A full discussion of the Gilbertian hypothesis as developed and modified by the writer, together with a somewhat extended account of the most interesting localities studied, will appear elsewhere. The object of the present article is briefly to outline the salient points in the theory, and to indicate a few of the more significant conclusions which may be based upon it.

Gilbert's statement[3] of the theory of lateral planation is simple and concise. He points out that downward wear of streams ceases when the load equals the capacity for transportation. Lateral corrasion then becomes relatively and actually of importance, and carves an even surface covered by a thin deposit of alluvium. By cutting laterally into each others' valleys and consuming all remnants of the intervening divides neighboring streams cooperate to carve a single plane of broad extent. Gilbert does not discuss many details of the process, and certain of his assumptions seem open to question. But the essence of the theory of lateral planation is stated with the clarity of logical deduction characteristic of his writings.

We may by further deduction expand Gilbert's idea to the following form: Every stream is, in all its parts, engaged in the three processes of (a) vertical downcutting or degrading, (b) upbuilding or aggrading, and (c) lateral cutting or planation. Under different conditions one or another of these processes may become more important, and the other two operate less vigorously or intermittently. If we imagine an isolated mountain mass in an arid region, it will be evident that the gathering ground of streams in the mountains, where greater precipitation occurs, will normally be the region where vertical cutting is at its maximum. Aggradation will be intermittent, local and temporary. Lateral cutting will be vigorous, and for every hundred feet of downcutting two or more hundred feet of lateral movement of the stream may take place. But even so the deepening process keeps the valleys youthful in character, with narrow bottoms and relatively steep sides. Valley deepening appears dominant, even if it be actually subordinate to lateral corrasion.

Far out from the mountain mass conditions are reversed. Each stream must distribute its water and its load over an ever-widening sector of country. The water disappears, whether by evaporation or by sinking into the accumulating alluvium. Aggradation is at its maximum, and vertical downcutting is intermittent in character and both local and limited in extent. Lateral corrasion may be dominant in fact, the streams shifting hundreds or thousands of feet laterally for every hundred feet of upbuilding. But the thing which impresses the observer is the ever-thickening mantle of alluvium. Aggradation appears dominant, even if it be actually subordinate to lateral corrasion.

Between the mountainous region of apparently dominant degradation and the distant region of apparently dominant aggradation there must be a belt or zone where the streams are essentially at grade, the balance between their capacity for transport and the load they carry being here as nearly perfect as conditions will permit. Both downcutting and upbuilding are at a minimum, while lateral corrasion is again dominant, not only in fact but also in appearance. Since the dominant lateral cutting takes place essentially at a constant level, its results are strikingly obvious. Interstream areas are consumed and the valley bottoms coalesce to give a single rock plane sloping in all directions away from the central mountain mass. On this plane the thin veneer of alluvium left by the shifting streams will remain until weathering, sheet floods and wind have disintegrated and removed everything down to bedrock.

It thus appears that in and about each desert range there should normally be found three concentric zones, in all of which lateral corrasion is actually dominant, but in each of which the three processes of degradation, corrasion and aggradation assume such strikingly different relations that each zone in turn appears to be dominated by a different process. (1) In the center is the *zone of degradation,* where vertical downcutting reaches its maximum relative importance. (2) Outside of and surrounding this central area is the *zone of lateral corrasion,* where lateral cutting attains its maximum relative importance. (3) Farther out, and encircling this latter belt, is the *zone of aggradation,* where upbuilding by deposition of alluvium has its maximum relative importance.

Heavily laden streams issuing from the mountain-

[3] G. K. Gilbert, "Geology of the Henry Mountains," 126–133, Washington, 1877.

ous zone of degradation are from time to time deflected against the mountain front. This action, combined with the removal of peripheral portions of interstream divides by lateral corrasion just within the valley mouths, insures a gradual recession of the face or faces of the range. Such recession will be aided by weathering as well as by the rain and rill wash; but it must occur even were these processes of negligible importance. Thus the three zones progressively contract, the central zone of degradation shrinking to smaller and ever smaller size. The zone of lateral corrasion in turn moves inward from all sides, while the zone of aggradation in its turn encroaches upon the smoothly bevelled outer areas of the zone of lateral corrasion. Thus nature provides a beautifully adjusted mechanism which insures that at every point within the initial mountain mass streams will ultimately be maintained at a given level in the balanced or graded condition until the work of planation is complete. Various causes may interrupt the normal cycle of lateral planation, but those will be discussed elsewhere.

Such, it seems to me, is the essence of the theory of lateral corrasion as we may properly deduce it from the initial idea so briefly set forth by Gilbert. If I have expanded his argument beyond the few words in which he stated it, if I have extended its scope beyond the local and restricted conditions to which he applied it, and have deduced far-reaching consequences which find no apparent support in his statements regarding "planation," I hope it will appear that each step in this expansion is logically to be traced back to the fundamental conception which we owe to Gilbert's penetrating mind.

Certainly there are many facts of field evidence which seem most readily to be explained on the theory as here elaborated. The theory implies that under proper conditions we should find occasionally preserved bed-rock surfaces near canyon mouths which possess the form of alluvial fans. Such surfaces have been observed cut in section by waves along the New Zealand coast, and exposed at several places on the flanks of ranges in central New Mexico. Another implication is that neither the bare rock floor nor the alluvial cover is significant of an early or late stage of the process of planation; either may be found in its appropriate zone at any stage of the cycle. In Arizona the rock floor is found about the greatly dissected and much shrunken Sacaton Mountains; in New Mexico at the base of the little dissected Sandias. Outlying erosion remnants of a range should on this theory rise rather abruptly from the inclined rock floor, unless preservation from lateral corrasion for an appreciable time has permitted weathering, rain and rill wash to change the angular contact into a profile more or less rounded. Both angular and rounded contacts are to be observed; but the number of cases in which outlying hills rise sharply from an inclined, thorough-going rock plane, either bare or thinly veneered with alluvium, suggests that lateral corrasion and not weathering is the dominant factor in shaping the topography. On the theory outlined above alluvial fans are normal features in their appropriate zone, even under static conditions, and are not necessarily indicative of faulting, warping, changes of climate or other special causes, as some authorities have suggested. The field evidence seems in harmony with the former, rather than with the latter view.

Faulting, warping, climatic change or simply decrease of stream load due to changes effected by erosion of the central mountain mass, may cause streams to entrench themselves in planes of lateral corrasion. New planes at successively lower levels, and usually with different angles of slope, may be formed. Remnants of such successive planes are common features in arid regions, and beautiful examples have been observed by the writer along the flanks of the Atlas Mountains in Algeria, among the folded mountains of South Africa, in New Zealand, and in our own arid southwest. By projecting the inclined surfaces of this type of outlying mesa remnant upward toward the neighboring range it will often be found that a corresponding surface high in the mountains neatly bevels the disordered structures of the mass. Hence high-level erosion planes on the flanks of mountains should not be accepted as evidence of faulting or uplift of the ranges, nor regarded as incipient pediments the development of which was interrupted by faulting or other disturbance. They may be the inner margins of once vast planes of lateral corrasion, no trace of the distal portions of which have survived the reduction of weaker rock to lower levels. Such high-level benches have been observed by the writer in the Cape Colony ranges, the mountains of the south island of New Zealand, and in various ranges of southern Arizona. They are well developed along the western border of the Southern Rockies north of Santa Fé, New Mexico, while the Rocky Mountain peneplane as observed west of Palmer Lake, Colorado, shows a perfection of planation, a degree of slope, and a sharpness of contact with minor "monadnocks" which lead me to suspect that it should rather be classed as the inner margin of a once far-spreading plane of lateral corrasion.

Fluvial peneplanes should not be confused with planes of lateral corrasion. The former are undulat-

ing rather than plane, grade imperceptibly into the slopes of monadnocks, have imperceptible regional slopes, deep residual soil, no wide-spread alluvial cover, are developed slowly with respect to base level, and are usually trenched by streams only when uplifted. The latter are true planes, exhibit more abrupt and sometimes angular contacts with erosion residuals, present regional slopes commonly obvious to the eye, have little or no residual soil but frequently a wide-spread blanket of alluvium, are developed rapidly without any necessary relation to base level, and may normally be trenched by streams without any change in the attitude or altitude of the areas affected. Peneplane remnants may safely be correlated over fairly broad areas; but planes of lateral corrasion may be developed at so many different levels simultaneously in a single region, or may be developed at the same level at such widely different periods, that correlation of their isolated remnants is both difficult and hazardous.

In the writer's opinion much of the topography widely attributed to eolian denudation by Passarge and others may with good reason be ascribed to lateral planation by intermittent streams. It has not been my good fortune to see typical portions of the Kalahari Desert, but inselberge of the eastern marginal area and other supposed eolian forms pointed out by those familiar with the true desert topography appeared to be capable of more rational explanation as the product of lateral corrasion. This and other aspects of this many-sided problem will receive more adequate treatment in the near future.

SCIENTIFIC EVENTS

RESOLUTIONS ADOPTED BY THE COUNCIL OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AT CLEVELAND

A Resolution on H. R. Bill 7884, Prohibiting the Use of Dogs for Medical Experimentation in the District of Columbia

(Unanimously adopted by the Council, December 31, 1930)

The American Association for the Advancement of Science, which has repeatedly recorded its protest against the enactment of legislation prohibiting animal experimentation for scientific and medical purposes, hereby protests against the passage of House Bill 7884 in the present Congress prohibiting the use of dogs for medical experiment in the District of Columbia.

The circumstances under which this bill was favorably reported, as set forth in the minority report, make abundantly clear that this bill should be recommitted to the Committee on the District of Columbia for full and proper consideration by the members and for adequate presentation of objections by opponents of the bill.

This association is in accord with the practically unanimous and often expressed authoritative voice of science and medicine that animal experimentation has conferred inestimable benefits upon mankind, as well as upon animals themselves, and is essential to the progress of the biological and medical sciences.

The history of medical discovery affords countless examples of the necessity for the use of dogs in certain kinds of experiment, as may be illustrated by the experiments leading to the recent discoveries of insulin in the treatment of diabetes and of liver extract in the treatment of pernicious anaemia.

The conditions under which animal experimentation is conducted in the government and medical laboratories in the District of Columbia afford every safeguard against the infliction of unnecessary suffering upon the animals.

No legislation of the character proposed in this bill has ever been enacted in spite of the efforts of anti-vivisectionists in this country and abroad for many years.

This association, with a membership of over nineteen thousand and representative of all the sciences of nature and of man, is confident that if the members of Congress become fully informed of the injury which would be inflicted upon the progress of curative and preventive medicine by such legislation H. R. Bill 7884 will not receive their favorable consideration.

A Resolution on the Approaching Observance of the Two-Hundredth Anniversary of the Birth of George Washington

(Adopted by the Council, January 1, 1931

WHEREAS, The Congress of the United States has created a commission consisting of high officers of the Government and a number of citizens appointed by the President, to arrange a fitting nation-wide observance of the two-hundredth anniversary of the birth of George Washington in 1932, and

WHEREAS, The purpose is to commemorate the life of a man who, in addition to his outstanding achievements in war and peace which were most vital to the creation of the United States of America, had broad interest in every walk of life, including the sciences and the fine arts, as is exemplified by his lifetime active participation in the engineering and science of his day, it is therefore

Resolved, That the council of the American Association for the Advancement of Science does hereby endorse the program of observance of the two-hundredth anniversary of the birth of George Washington, to take place in 1932, and commends to the members of the association their participation in the celebration, and it is further

Resolved, That a copy of this resolution be transmitted to the George Washington Bicentennial Commission, Washington, D. C.

A Resolution on the Need for the Preservation of Redwood Areas in California

(Adopted by the Council, January 1, 1931

WHEREAS, full knowledge of biological phenomena such as is required for advance in science and education requires complete protection of primitive associations of plant and animal life, and

WHEREAS, the primitive areas of the coast redwood forest in California constitute some of the most interesting and important life associations, and

WHEREAS, the Save the Redwoods League is vigorously advancing the cause of protection of the coast redwood forest plant and animal associations of California, it is

Resolved, That the council of the American Association for the Advancement of Science expresses its strong approval of the efforts of the Save the Redwoods League and of the State of California to preserve the primitive redwood areas, and respectfully urges that in carrying out this program every effort be made to secure representative areas sufficiently varied to illustrate the various types of forest, and of its associated flora and fauna, and sufficiently large to guarantee for the future the complete protection of these primitive floral and faunal associations.

A Resolution on the Need for the Preservation of Everglades Areas

(Adopted by the Council, January 1, 1931)

WHEREAS, the southern end of the Florida peninsula contains biological features of unique character, which are found nowhere else within the area of the United States, and

WHEREAS, it has been proposed to establish a national park for the preservation of these features in their primitive state; therefore the council of the American Association for the Advancement of Science

Approves of the establishment of such a park, but only under conditions that will completely exclude railway and other commercial developments and fully protect the floral and faunal associations within the limits that are to be established.

IN HONOR OF PROFESSOR JAMES EWING

A TESTIMONIAL dinner was given on Saturday, January 31, at the Hotel Pierre in New York City in honor of Dr. James Ewing, president of the medical board and director of cancer research at the Memorial Hospital of New York City. Dr. Ewing has just completed his thirty-second year as professor of pathology in the Cornell University Medical School.

There were four hundred invited guests including those eminent in the field of science from all parts of the country. The toastmaster of the dinner was Dr. George D. Stewart, formerly president of the American College of Surgeons and of the New York Academy of Medicine.

The speakers were: Surgeon General Hugh S. Cumming, of the U. S. Public Health Service; President Livingston Farrand, of Cornell University; Dr. Howard A. Kelly, formerly professor of gynecology at the Johns Hopkins Medical School and now surgeon and radiologist to the Howard Kelly Hospital in Baltimore; Dr. Francis Carter Wood, director of the Crocker Institute of Cancer Research and editor of *The American Journal of Cancer;* Dr. John A. Hartwell, president of the New York Academy of Medicine; Dr. James B. Murphy, member of the Rockefeller Institute for Medical Research; Mr. Archibald Douglas, of the executive committee and board of managers of the Memorial Hospital; Dr. C. C. Little, managing director of the American Society for the Control of Cancer; Mr. Thomas DeBevoise, lawyer; Dr. G. Canby Robinson, dean and director of New York Hospital-Cornell Association, and Dr. Frank E. Adair, attending surgeon, Memorial Hospital.

The January issue of the *Annals of Surgery* was dedicated to Dr. Ewing and published as a tribute to his unique position throughout the world in the field of cancer research. It contained articles from forty-six contributors of international preeminence in this field. At the dinner an illuminated copy of this volume was presented to Dr. Ewing by Dr. Frank E. Adair, who had been associated with Dr. Lewis S. Pilcher, the editor of the *Annals of Surgery,* in editing this special "Ewing Cancer Number."

A letter was received from President Hoover in which he stated: "To the Medical Board of the Memorial Hospital, New York. Gentlemen: I want to thank you warmly for your kind invitation to attend the testimonial dinner in honor of Dr. James Ewing on January 31. I deeply regret that my duties here do not permit me to be present. I should like to share in person in paying honor to such a useful and distinguished citizen, whose work as scientific researcher, teacher and author has done so much to forward the attack on the problem of cancer in particular and of disease in general. Such a career is a service and an inspiration to humanity and deserves the tribute of public praise. Yours faithfully, Herbert Hoover."

A cablegram was sent by Madam Curie as follows: "Congratulations on the well-earned recognition of your important contribution to radiotherapy and your work in the field of cancer." A letter was read from Governor Roosevelt in which he said that Dr. Ewing's achievements in the field of cancer have received national and international recognition and it is a real pleasure to congratulate him upon them as well as upon his invaluable service to the state.

The sentiment expressed at the dinner by the speakers was one of profound admiration for Dr. Ewing, and it was a privilege to pay homage to this unique man in the field of medical science.

B. J. L.

THE NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL AND COLUMBIA UNIVERSITY

THE incorporation in the educational system of Columbia University of the New York Post-Graduate Medical School and Hospital, the oldest institution in the United States engaged solely in the teaching of post-graduate medicine, was announced at the annual dinner of the Post-Graduate Faculty Association held at the Biltmore Hotel on January 31.

The agreement between the two institutions, effective on July 1, 1931, said Dr. Arthur F. Chace, president of the New York Post-Graduate Medical School

and Hospital, makes the Post-Graduate an integral part of the Columbia University teaching system and, in the future, the center of a comprehensive program of post-graduate medical teaching sponsored by the university.

To carry out the program for placing all the post-graduate teaching on a university basis, provision for an interlocking of the governing bodies has been made. Dr. Butler has been elected a member of the corporation and of the board of directors of the New York faculty, which will be under the jurisdiction of the University Council. Other members will be appointed in the near future.

Dr. Chace presided at the dinner. The speakers included Dr. James F. McKernon and Dr. Willard C. Rappleye, the newly elected dean of the College of Physicians and Surgeons.

Among congratulatory letters read at the dinner was one from Dr. Ray Lyman Wilbur, Secretary of the Interior, who is chairman of the Committee on the Cost of Medical Care. Secretary Wilbur said: "I am very much pleased with the opportunity that is opening for continuous educational facilities for the practitioner in the State of New York. I have felt for years that it is one of the most important things that could be done for the advance of medicine in this country."

The affiliation, according to Dr. Edward H. Hume, executive vice-president of the school, is a response to a community demand that the medical profession regard itself more fully as the servant of the social order. Dr. Hume believes that "the new opportunity of the Post-Graduate Medical School, with its fifty years of experience in the teaching of the practitioner, and its new university association, is to make available to the medical profession a center of increased power where the practitioner's powers may be renewed, and his practice raised to a higher level." Starting as a secession from a university medical school, and continuing for nearly fifty years as an independent institution, the institution has become once more a member of a university.

THE BRAUN-SCHUCHERT COLLECTION

DR. CHARLES SCHUCHERT, professor emeritus of paleontology at Yale University, has given the Peabody Museum the Fred Braun collection of invertebrate fossils and other objects of natural history. The gift will be known as the Braun-Schuchert Collection.

It required five large motor vans to transport the collection from its storage quarters to Peabody Museum, as the invertebrate fossils alone number almost 100,000 specimens. Besides these fossils, the gift includes a collection of over 3,000 mineral specimens, a large quantity of archeological material, and a conchological collection of about 10,000 specimens.

Fred Braun, who died in 1918, was a dealer in natural history materials, who began his business career in Cincinnati about 1870. In later years he traveled widely in this country and in Europe, visiting most of the localities which had classical collections of fossils, to gather material for sale or exchange. In some places he opened extensive quarries and at one time he employed as many as 20 quarrymen. Throughout his long life as a dealer, it was his ambition to build up a collection of invertebrate fossils that would be second to none, and into this private collection went the majority of the choice specimens that came into his possession. During his declining years, as adversity overtook him, Braun was obliged to sell certain portions of his great collection, but clung to most of it, and kept it together in spite of his distress. Upon his death in 1918, the collection came into the possession of his friend, Mr. G. E. Ashby.

Professor Schuchert, himself a native of Cincinnati, had been acquainted with Braun since his youthful days in that city. Through later visits to Braun after he had moved to Brooklyn, Professor Schuchert came to appreciate the extent of this great collection. For many years he hoped to secure the collection for Yale, and in 1916 attempted to raise the funds for its purchase. Although at the time this proved to be impossible, due to conditions raised by Braun, Professor Schuchert never gave up the hope which he has just brought to reality by privately purchasing the collection to present to the Peabody Museum.

In 1929 the Academy of Natural Sciences of Philadelphia awarded Professor Schuchert the Hayden Memorial Geological Medal, an honor given once in three years for preeminent research in geology, paleontology and related sciences. At commencement last year Yale University conferred upon him the honorary degree of doctor of science. In presenting him for the degree, Professor William Lyon Phelps, as public orator, described him as "one of the most distinguished scientists of Yale, in the front rank of paleontologists, and the world's leading authority on paleo-climatology."

CONFERENCE ON MEDICAL EDUCATION

DR. RAY LYMAN WILBUR, Secretary of the Interior, will deliver the opening address on February 16 at the Palmer House, Chicago, at the first session of the three-day annual congress on medical education, licensure and hospitals called by the council on those subjects of the American Medical Association. Dr. Wilbur is chairman of the council. He will discuss mental health as a national problem, which will be the keynote of three sessions.

State and Federal provision for the care of the mentally ill will be discussed by Dr. Walter L. Treadway, assistant surgeon general of the United States Public Health Service, and Dr. Samuel W. Hamilton, of White Plains, New York; Dr. Allen Jackson, of Danville, Pennsylvania; Dr. George S. Stevenson, of the National Committee for Mental Hygiene, New York, and Dr. Lawson G. Lowrey, director of the Institute for Child Guidance, New York, will speak on the mental hygiene movement.

Dr. Clarence M. Hincks, director of national committees for mental hygiene in the United States and Canada, will describe the work of the organizations. The relationship of mental health to medical education will be discussed by Dr. Franklin G. Ebaugh, of Denver; Dr. C. Macfie Campbell, of Boston, and Dr. H. Douglas Singer, of Chicago.

Among those who will speak on the licensing of physicians to practice medicine at a meeting of the Federation of State Medical Boards in conjunction with the congress will be Sol Ullman, Deputy Attorney General of New York State. Mr. Ullman will talk on the control of unlicensed practitioners. Dr. Frederick C. Warnshuis, of Detroit, will speak on "Who Shall Be Permitted to Continue the Practice of Medicine?" Other speakers on kindred topics will be Drs. William Jepson, of Sioux City, Iowa; Walter F. Donaldson, of Pittsburgh, and H. M. Platter, of Columbus, Ohio.

Four sessions of the congress will be devoted to various problems in the teaching of medicine. The speakers will include Dr. Charles P. Emerson, Dean of the Indiana University School of Medicine, Indianapolis; Dr. Wilburt C. Davison, Dean of Duke University School of Medicine, Durham, N. C.; Dr. Willard C. Rappleye, newly appointed Dean of Columbia University College of Physicians and Surgeons; Dr. William J. Mayo, of Rochester, Minnesota; Dr. Clifford C. Grulee, of Chicago, and Dr. James S. McLester, of Birmingham, Alabama.

The training of internes, hospitals and the law, and special facilities for caring for convalescents will be discussed at three sessions.

MEETING OF GEOLOGISTS AT TORONTO

THE forty-third annual meeting of the Geological Society of America and its affiliated societies, the Paleontological Society and the Mineralogical Society of America, was held at the University of Toronto, on December 29, 30 and 31.

The meeting was one of the largest in the history of the society, 519 persons being registered. Ninety-six scientific papers were presented before the Geological Society, and the programs of the affiliated societies were also crowded.

The address of the retiring president, Dr. R. A. F. Penrose, Jr., "Geology as an Agent in Human Welfare," was delivered the evening of December 29 at the Royal York Hotel, and was followed by a special entertainment provided by the Toronto hosts. The annual dinner was held in the Great Hall of Hart House at the university, on the thirtieth. The third award of the Penrose Medal of the Geological Society of America was made at the annual dinner, the medal being accepted by M. Rochereau de le Sablière, French consul at Toronto, in the absence of the recipient, Professor François Antoine Alfred Lacroix, of the Natural History Museum, Paris.

The officers of the society for the year 1931 are:

President—Alfred C. Lane.
Vice-presidents—Thomas L. Walker, Henry B. Kummel, Edgar R. Cumings, Alexander H. Phillips.
Secretary—Charles P. Berkey.
Treasurer—Edward B. Mathews.
Editor—Joseph Stanley-Brown.
Councilors—Herdman F. Cleland, Elwood S. Moore, W. C. Mendenhall, W. J. Mead, Sidney Powers, Donnel F. Hewett.
Representative of the Cordilleran Section—Eliot Blackwelder.

Announcement was made of the election of 28 new fellows and five additional foreign correspondents.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM H. WELCH was the guest of honor at a dinner at the Maryland Club, Baltimore, on January 29, at which a specially bound copy of a memorial volume, recounting the world-wide celebration of his eightieth birthday, was presented by Mr. John D. Rockefeller, Jr. The book is titled "William Henry Welch at Eighty" and contains the special inscription: "Dr. Welch, this is the first copy of a book which has been made for remembrance. It is a token of affection from friends who desire that posterity may read the story of the day when you were eighty." Dr. William G. MacCallum presented Dr. Welch with a specially designed scrap-book containing more than 3,000 clippings of press notices about the eightieth birthday celebration. Dr. William H. Howell presented a volume bearing congratulatory messages. Mr. John A. Kingsbury, secretary of the Milbank Memorial Fund, presented a volume which contained tributes to Dr. Welch from universities and societies of medicine all over the world. Dr. Simon Flexner presided. Reports of the celebrations in honor of Dr. Welch's eightieth birthday on April 8 and subse-

quently have been printed in SCIENCE, including the address made in Washington by President Hoover and Dr. Welch's reply.

THE new laboratory building to be constructed at the Scripps Institution of Oceanography of the University of California will be known as William E. Ritter Hall, in honor of Professor Emeritus Ritter, who was chiefly concerned with the station's founding and who was its first director. The plans call for a building two stories in height with an additional basement floor, and 46 by 100 in floor area, to be erected at a cost of $120,000. Space is to be allotted for laboratories of dynamical oceanography and marine meteorology, chemistry, marine bacteriology and the physiology of marine organisms.

A PORTRAIT of Professor Harry Burr Ferris, for forty years a teacher of anatomy in Yale University, has been presented to the Yale School of Medicine by a group of his former students and colleagues, of whom 631 participated in making the gift. The portrait is the work of John Quincy Adams, of Vienna. It will hang in the Ferris room, a library and seminar room for the use of students of anatomy, as a permanent tribute to the esteem and affection in which Professor Ferris is held. Professor Ferris in 1897 was appointed E. K. Hunt professor of anatomy, a chair which he has filled since that date.

AT the annual banquet of the New York State Veterinarians Dr. Veranus A. Moore, until his recent retirement director of the New York State Veterinary College and state veterinarian of New York, was presented with the honorary diploma conferred last summer by the International Veterinary Congress at London. The presentation was made by Dr. John R. Mohler, chief of the United States Bureau of Animal Husbandry. Dr. Moore is now one of the two honorary members in America of the Royal College of Veterinary Surgeons. Dean Pierre A. Fish presided at the dinner.

A UNITED PRESS dispatch reports that the Pasteur Institute in Paris has dedicated a bronze monument to M. Joseph Meister. Meister, as a boy, forty-five years ago, was the first person to allow M. Pasteur to inoculate him with the rabies serum. The statue commemorating the event shows the farm boy grappling with a mad dog. M. Meister is now living in Paris.

DR. KARL LANDSTEINER, a member of the Rockefeller Institute for Medical Research, has been elected an honorary member of the Royal Swedish Academy of Science.

THE Council of the Geological Society of London has this year made the following awards: The Wollaston Medal to Dr. Austin Williams Rogers, of the Geological Survey of the Union of South Africa, in recognition of the value of his work on the geology of South Africa. The Murchison Medal to Dr. George Walter Tyrrell, of the University of Glasgow, for his work on the igneous rocks of the West of Scotland. The Lyell Medal to Mr. Ernest Clayton Andrews, of the Geological Survey of New South Wales, for his researches on the economic geology of New South Wales and on physical geology. The Bigsby Medal to Dr. Norman L. Bowen, of the Geophysical Laboratory, Carnegie Institution, Washington, D. C., in recognition of the value of his researches on the physical chemistry of igneous rocks. The Wollaston Fund to Dr. Robert G. S. Hudson, for his work on the stratigraphy and paleontology of the carboniferous rocks of Yorkshire. The Murchison Fund to Dr. Cyril James Stubblefield, for his researches on the Cambrian rocks of Shropshire and on invertebrate paleontology. A moiety of the Lyell Fund to Dr. Oliver M. B. Bulman, in recognition of his work on the Cambrian rocks of Shropshire and of his paleontological researches. A second moiety of the Lyell Fund to Mr. William Howson Wilcockson, for his work on petrology and economic geology.

OFFICERS of the Washington Academy of Sciences have been elected as follows: *President,* N. A. Cobb; *Resident Vice-presidents,* J. M. Cooper, Walter Hough, L. A. Rogers, Alexander Wetmore, H. B. Humphreys, R. E. Gibson, Paul Bartsch, A. C. Clark, H. L. Whittemore, H. C. Macatee, C. H. Birdseye, H. L. Curtis, G. W. Vinal, W. E. Parker, Harold Morrison, F. C. Craighead, F. V. Coville, G. R. Mansfield; *Non-resident Vice-presidents,* Cyrus Adler, W. D. Coolidge; *Corresponding Secretary,* Paul E. Howe; *Recording Secretary,* Charles Thom; *Treasurer,* H. G. Avers; *Managers for the term of three years ending 1934,* N. M. Judd, L. B. Tuckerman.

DR. WM. CHARLES WHITE was elected president of the Cosmos Club, Washington, at the annual meeting of the club in January.

FOLLOWING the annual meeting of the American Institute of Consulting Engineers, held in New York on January 19, the council re-elected Colonel Frederic A. Molitor as president, and Philip W. Henry as secretary and treasurer. Robert Spurr Weston, of Boston, was elected vice-president, and Colonel Molitor, Mr. Weston and F. A. Burdett as the executive committee. The committee on admissions comprises G. A. Orrok, H. R. Buck, of Hartford, Connecticut, and F. C. Noble.

DR. HARLAN T. STETSON, professor of astronomy at the Ohio Wesleyan University and director of Perkins Observatory at Delaware, Ohio, has been appointed non-resident lecturer in the Graduate School of the

Ohio State University. This is in accordance with the plan approved by the trustees of both the Ohio Wesleyan and the Ohio State University for the cooperative graduate program in astronomy and astrophysics, whereby graduate students of the State University may carry on research work for advanced degrees at the Perkins Observatory.

Dr. Floyd K. Richtmyer, professor of physics at Cornell University since 1918, has been elected dean of the Graduate School by the trustees. Professor Richtmyer succeeds Dean Rollins A. Emerson. He took up his new work on February 6.

Dr. Charles Kephart Swartz, collegiate professor of geology in the Johns Hopkins University, will retire at the end of the academic year.

Dr. George J. Heuer, surgical director of the Cincinnati General Hospital and Holmes professor of surgery in the University of Cincinnati College of Medicine, has been appointed surgeon-in-chief of the New York Hospital and professor of surgery in Cornell University, to be effective July 1. He will remain in Cincinnati until that time, when he will undertake the organization of the surgical department in the new building of the New York Hospital-Cornell Medical College Association.

George E. Marvin, instructor in the department of entomology at the Wisconsin College of Agriculture, has tendered his resignation, to accept a position with the new bee-culture laboratory in the Bureau of Entomology of the U. S. Department of Agriculture.

Geo. P. Gray, formerly chief of the Division of Chemistry of the California State Department of Agriculture, has been named director of the California Soil Improvement Committee and assumed his new work on January 1.

Dr. W. S. Leathers, dean of the Vanderbilt University Medical School, has been appointed a member of the National Advisory Health Council of the Federal Public Health Service.

Dr. W. Heitler, of the University of Göttingen, will be in residence at the Ohio State University during the spring quarter as visiting professor of theoretical physics. He will lecture on "The Quantum Theory of Valence and Related Phenomena." Professor Raymond T. Birge, of the University of California, and Professor John S. Foster, of McGill University, have been appointed to special lectureships for the summer quarter of 1931. Professor Birge will lecture on band spectra and Professor Foster on the Zeeman effect, Stark effect and related topics.

Dr. R. A. Fisher, chief statistician of Rothamsted Experimental Station, Harpenden, England, will spend eight weeks in the United States during the coming summer. He will be in residence on the staff at the Iowa State College during the first half of the summer session, from June 16 to July 24 and later will visit a number of colleges, universities and experiment stations throughout the country. In connection with Dr. Fisher's visit, the Iowa State College announces a special group of summer session courses covering the theory and application of statistics.

Dr. Ernest Little, dean of the New Jersey College of Pharmacy of Rutgers University, sailed for Genoa on February 3. Dr. Little, who is on an eight months' leave of absence from the college, will spend much of his time in the Medical Chemical Institute of the University of Graz. He also expects to visit several other universities and scientific institutions that are doing work which is of especial interest in the fields of pharmacy and medicine.

Professor Malcolm H. Soule, of the Hygienic Laboratory of the University of Michigan, is spending the winter quarter in special research at the School of Tropical Medicine, San Juan, Porto Rico. He will give a series of lectures to the faculty and students while in residence. Professor Ernest Carroll Faust, of Tulane Medical School, will spend two weeks at the school during the present month and is giving a series of lectures during his visit.

Professor R. A. Millikan, of the California Institute of Technology, recently lectured at Amherst College on "Exploring the Universe." On January 23 Mr. John Bellamy Taylor, consulting engineer for the General Electric Company, gave a lecture on "Audible Light."

Dr. Austin F. Rogers, of Stanford University, gave an illustrated lecture on the silica minerals before faculty and student members of the department of geology of the University of Arizona on January 7.

The annual lecture and address to the initiates before the University of Michigan Chapter of the Society of Sigma Xi will be delivered by Herbert F. Moore, research professor of engineering materials of the University of Illinois.

Dr. E. M. East, of Harvard University, will deliver the fifth Harvey Society Lecture at the New York Academy of Medicine, on Thursday, February 19. His subject will be "Possible Immunological Reactions with Plants."

Dr. Henry Norris Russell, professor of astronomy at Princeton University, is giving in Boston a course of six Lowell Lectures on "The Physics of the Stars."

THE thirty-sixth general meeting of the German Bunsen Society for applied physical chemistry will take place from May 25 to 27 in Vienna. The subject of the symposium will be: "Recent Progress in the Science of Metallurgy with Particular Reference to Light Metals." The arrangements have been undertaken by Professor Dr. Speeketer.

THE School of Tropical Medicine, San Juan, has received a grant of $36,000, extending over a period of four years for the study of nutrition in Porto Rico. The work was begun on January 1 and will be under the direction of Professor Henry C. Sherman, of Columbia University.

MR. DAVID E. ROSS, president of the board of trustees of Purdue University, has purchased and deeded to the university three tracts of land, 157 acres in all, to be developed as the Purdue Airport. The tracts of land are level and without trees. They lie half a mile southwest of the campus and adjoin Edgewood farm, owned and operated by the university, which could be used as part of the landing field, in case this were found desirable at a later date, giving a combined tract of 317 acres of level land.

THAT the present name of the Massachusetts Agricultural College is a misnomer in that it applies to only one part of the college was the main point in the argument presented by a committee of the trustees to the state legislative committee on education at the State House on January 28, in support of the petition of George H. Ellis, vice-president of the trustees, to change the name of the college to the Massachusetts State College. Mr. Ellis stated that the action would involve no change in the purpose or scope of the college. There was no opposition.

BARON HARINXMA, accompanied by Dr. G. A. Brouwer, the biologist of the Natural History Museum of Leiden, Holland, has set out from Addis Abeba, Abyssinia, at the head of an expedition which will traverse some of the wildest portions of the African continent. The expedition, which is composed of twenty men, transported by forty mules and three camels, will proceed through the Great Rift Valley to Lake Rudolph. The party will make a careful study of the fauna of the region through which it passes and hopes to secure many photographs of the wild animal and bird life which abounds in the districts to be visited. After leaving the Ethiopian frontier in the vicinity of Lake Rudolph the expedition will go to Movale in the northern frontier district of Kenya, thence to Meru, British East Africa, either by way of Marsabit, or the more eastern route of the Lorian swamps.

AN Associated Press dispatch reports that plans for four Russian Arctic expeditions have been completed by the All-Union Institute of the North. The first will leave Archangel for Vladivostok to search for the supposed Andreyev Land, believed to exist between Wrangel Island and the islands north of Siberia. So far as known this part of the Arctic has never been visited. The expeditions will travel on an ice breaker and carry an airplane for scouting. A second expedition will go to Franz Josef Land to replace workers at the meteorological station and carry on further scientific work. A third group will investigate the natural resources of the Chukotsky Peninsula, Siberia. The fourth will search for huge deposits of coal reported in the Khoradlaksk Mountain Ridge north of the Lenz River.

SECRETARY OF AGRICULTURE HYDE has received from the American Association of Economic Entomologists formal notification of resolutions which the organization adopted at its annual meeting in Cleveland, December 29 to January 1. The resolutions were as follows:

WHEREAS, The establishment of the Mediterranean Fruit Fly in Florida constituted a great menace to the horticultural industries of the South and West, and,

WHEREAS, The campaign to eradicate this pest has accomplished results far beyond our expectations, and,

WHEREAS, This campaign is one of the outstanding achievements in the annals of economic entomology; be it therefore

Resolved, That the American Association of Economic Entomologists here assembled extends to the Plant Quarantine and Control Administration of the United States Department of Agriculture and to the State Plant Board of Florida its congratulations on the great work accomplished to date; and be it further

Resolved, That a copy of this resolution be forwarded to the President of the United States, the Secretary of Agriculture, the Governor of Florida, and to the officials of organizations involved.

THE Berlin correspondent of the *Journal* of the American Medical Association states that the German Federal Health Council received information in December in regard to the investigations carried out in the federal bureau of health and in the Robert Koch institute in Berlin, in the Deutsche Forschungsanstalt für Tuberkulose in Hamburg, and in the pathologic institute of the University of Berlin, on the regrettable occurrences in Lübeck. The report of Professor Ludwig Lange, of the federal bureau of health, in which Professor Neufeldt, of Berlin, and Dr. Kirchner, of Hamburg, concurred, expresses the following conclusions: (1) The illnesses and deaths of infants that occurred in Lübeck following the Calmette vaccination against tuberculosis were not due to the Calmette procedure as such. (2) The assumption that in Lübeck a mixing of virulent tubercle bacilli with the Calmette cultures occurred as a result of an unrecognized error of manipulation appears extremely probable. After careful deliberation, the federal health council upholds the decision reached in 1927 to the effect that the ques-

tion of immunization against tuberculosis in man is so imperfectly elucidated by the experimental and statistical observations that a general application of such immunization (particularly when living bacilli are employed, even though in an attenuated form) appears ill advised, for the present. In order to prevent in the future such occurrences as took place in Lübeck, the federal health council regards as essential an extension and accentuation of the legal requirements with respect to the preparation, distribution and use of vaccines of all kinds. A commission was appointed charged with the duty of submitting to the federal health council suitable proposals, as soon as possible. With this decision, which brings no surprises, the investigation, from the scientific point of view, is brought to a close. It remains only for the courts now to give their decision. From the existing material, it may, to be sure, appear doubtful whether the courts will reach any definite results.

The American Society for the Study of Disorders of Speech has entered on a nationwide cooperative study of the treatment of stammering. Twenty-eight specialists from all parts of the United States presented papers on the principles of treatment of stammering at the annual convention of the society held in Chicago on December 30 and 31 and January 1. The papers read at this convention are to be mimeographed and turned back into the hands of each participant on the program and to attendants at the convention and their students and associates (but not to the public) for a year of analytic study, when another series of papers on treatment will be presented at the annual convention to be held next December in Detroit. A committee was appointed to publish an abridgement of these papers for the public. Provision was also made at this convention for the appointment of both an executive committee and an advisory committee on study and research into the treatment of stammering. The executive committee will consist of the members of the council of the society. The advisory committee has not yet been appointed. After this study has reached a sufficient degree of clearness, it is intended to carry out definite plans of research aimed to determine the relative efficiency of such conceptions of treatment as seem to be most worth while. This study will consume a number of years, and should prove to be very valuable.

For the past two years, the Association of American Medical Colleges has been making a check-up on the work done by the freshmen in the medical colleges in membership in the association. The purpose of this work is to encourage cooperation on the part of the institutions in which these students have done their premedical work. Complete records are obtained on each student who did not carry on his medical studies in the medical school which is a part of the institution in which this premedical work was done because related institutions are usually supplied with this information of the performance of their own students. Unrelated institutions have not up to the present time had any way of ascertaining the character of the work done by their premedical students who have studied medicine in medical schools other than their own. It is planned to send out these reports to colleges of liberal arts and science, but the expense involved has made it impossible to complete the task. Any college or university desiring information on its premedical students can obtain it by writing to the secretary of the association, Dr. Fred C. Zapffe, 25 East Washington Street, Chicago. During the years that this study has been carried on, the freshmen entering medical colleges have come from approximately 650 colleges of liberal arts and science. About one half (3,250) of the matriculants of each year have come from unrelated institutions.

The Paris correspondent of the *Journal* of the American Medical Association writes that the question of public health in the French colonies is vital as regards not only the European colonists but also the natives. The mortality of the natives from disease, in connection with such undertakings as the building of railways and the digging of canals, tends to diminish the local labor supply; and the child mortality, which remains high, is gradually depopulating the country and preparing the way for an invasion by more hardy or better educated races. An endeavor has been made to develop medical facilities for the natives, including dispensaries, and laboratories for the preparation of vaccines, and, finally, to introduce a more rational diet. The natives are nearly always underfed, contenting themselves with fruits and roots. The number of colonial physicians has been considerably augmented, but an adequate number can not be secured without offering attractive salaries, which have thus far not been forthcoming. The creation of schools of colonial medicine at Bordeaux and at Marseilles and of a special institute at Paris for the study of parasites and tropical microorganisms has completed the vast program. For the past ten years, the budgets of public health for each colong have been regularly augmented: on the Congo and in Cameroons, Indo-China, Madagascar, French West Africa, and especially in French Equatorial Africa, where the native mortality is the highest. The sum of $12,000,000 has been provided for the first three colonies, $1,680,000 for French West Africa, $2,400,000 for Madagascar, and $3,000,000 for French Equatorial Africa.

DISCUSSION

EVIDENCE OF A LOWER LEVEL OF LAKE SUPERIOR

EARLY this fall a sample of peat was sent to the writer for pollen analysis. It had been dredged up from a depth of 54 feet below the surface of Lake Superior, about one and one half miles west of Sand Island, Bayfield County, Wisconsin. According to Professor J. A. Merrill, of the Superior State Teachers College, the deposit is in 40 feet of water and under 14 feet of lake sand, covers a considerable area, and is *in situ*. Another deposit is reported between Cat Island and North Twin Island, about 23 miles east northeast of Sand Island.

These two peat deposits would indicate a lake level at least 54 feet below the present level, which is not in accordance with our present ideas concerning the postglacial history of the region.[1] The unaltered state of the peat would strongly suggest that it was not of interglacial age, but postglacial, and probably associated with the Nipissing Stage of the Great Lakes.

Examination of the peat shows it to be remarkably well preserved. It is well stratified, and separates in layers when soaked in warm water. Several plant tissues are recognizable without special treatment of the peat. These are *Sphagnum*, leather leaf (*Chamaedaphne calyculata*) leaves, balsam fir (*Abies balsamea*) cone scales, and *Carex* achenes and rootstocks. The pollens in the peat are also well preserved, and are those of plants found in and near a typical northern peat bog. Spruce pollen is the most abundant form, and *Sphagnum* spores are second in abundance. Pollens of birch, heaths, sedge, willow, and several composites have been observed, but only tentatively identified. Numerous dark-colored spores of fungi also have been found. Besides many unknown pollens and spores, there occur a few fragmentary parts of small insects.

L. R. WILSON

UNIVERSITY OF WISCONSIN

THE STRUCTURE OF SOME INDUSTRIAL DIAMONDS

THE catalog of a large European dealer in diamonds used for industrial purposes contains the interesting information as to the relative structure and hardness of several different forms in which carbon is found in nature. Diamonds for industrial uses are classified into *carbons* (carbonado, black Brazilian diamonds), *ballas*,[1] and *boarts* (borts), which they describe as follows:

Boarts are more or less transparent crystals, of bright appearance occurring in the most varied shapes, and sometimes in twin and multiple crystal formation—Brazilian boarts rank first in point of hardness, followed in approximate order of merit by Australian, South West African and Cape.

Carbons (or carbonados) differ essentially from boarts in their structure. They are often described as amorphous diamonds, but really consist of microscopically small dark octahedrons, and are, consequently, a porous cluster of minute diamond crystals, fine to close-grained. The fracture of a good carbon should resemble the structure of fine steel. Not being built up in countless thin layers, they are much less fragile than boarts and unlike the latter, can be used until entirely consumed. The intense hardness of carbons is extraordinary, and considerably exceeds that of boarts.

Ballas are comparatively rare, and are found in South Africa and Brazil. They are non-porous, mostly roundish in shape, and consist of innumerable, well-formed, minute crystals grouped in concentric formation around a nucleus. On account of their structure, they have no defined cleavage planes, and are, invariably, of extraordinary hardness. Strictly speaking, they are not harder than the best carbons, but tougher on account of their structure. Round white diamonds are often wrongly described as ballas, but these are merely boarts of round shape, which being easily cleaved, can in no wise be used in place of ballas.

Brazilian ballas is used to test the hardness of carbons. When the two are rubbed together, a white mark indicates that the carbon is harder, while a dark-brown mark indicates the carbon is harder. Where both stones are of equal hardness, *no* mark results on either.

These facts seemed to indicate that, as is the case with steels, the hardness is greatly influenced by grain size.[2] The American representatives of the dealers kindly loaned me a small ballas and two pieces of carbon, one very hard, the other softer. About two years ago Professor George L. Clark was good enough to take x-ray spectrograms of the three specimens. The results indicate that the ballas was composed of a great number of small crystals, the softer carbon of smaller and more numerous crystals, while in the harder carbon many of the crystals were approximately of colloidal dimensions, the rings of the x-ray spectrogram being continuous, with many small spots.

[1] Frank Leverett, "Moraines and Shore Lines of the Lake Superior Region." U. S. Geol. Sur. Prof. Paper 154–A (1929).

[1] The word "ballas" has not been found in any dictionary consulted, but seems to be a modified form of the Portugese *balas* meaning *bullets*. The Spanish and Portugese word *bola* means ball, whence is derived the Argentine *bolas* used much as our lasso. Through the Latin *ballista*, the word goes back to the Greek βαλλειν, meaning to throw. Palla is an Old German form, and the golden balls of the house of Medici, now used by pawn-brokers, were known as *pallé*, which was the rallying cry of the Medicis.

[2] Samples of ballas and carbon were exhibited before the American Institute of Mining and Metallurgical Engineers in the course of a discussion. See *Trans.*, Vol. C, 29 (1929).

In J. W. Mellor's monumental book, Vol. V, p. 720 (1924), it is stated: "Boart and carbonado are usually regarded as forms intermediate between diamond and graphite." But the photographs indicate that the crystalline form throughout is that of diamond, the differences in hardness being primarily consequent on variations in the structure and particle size of the aggregates.

JEROME ALEXANDER

NEW YORK, N. Y.

BACTERIAL STEM-ROT DISEASE OF HYBRID SEEDLING CANES

IN October, 1930, a bacterial stem-rot disease of hybrid seedlings canes appeared sporadically in the cane culture of the College of Agriculture at Los Baños, Laguna, Philippine Islands. Later the same disease was observed on hybrid canes in the sugar cane plantation of the Calamba Sugar State at Canlubang, Laguna, and in the sugar cane plantation of the Pampanga Sugar Development Company at Del Carmen, Pampanga. Affected plants show pale yellow color on the foliage followed by wilting of the entire plant. When weather conditions favor, the tops of the diseased plants fall over as a result of the rotting of the tender tissues of the shoot.

Microscopic examination of diseased plants showed the presence of abundant motile bacteria between the cells in the young stages and within the cells in advanced stages. The vascular tissues are apparently free from the bacterial invasion.

The bacterium has been isolated and grown in pure culture. Inoculation of healthy plants with the pure culture of the bacterium reproduced the disease. The organism is of the genus *Bacillus* Cohn., since peritrichiate flagella are demonstrated by proper staining methods. The causal bacterium is a cylindrical rod with more or less rounded ends. The cells occur singly or in pairs, occasionally in chains, and in clumps in 24 to 48-hour-old culture. Films prepared from the juice of infected canes and stained with aniline gentian violet gave measurements of the cells from 0.95 to 2.2 by 0.5 to 0.7 μ. Spores are not formed. Thin capsules are formed in three-day-old nutrient agar slants. The cells are motile by means of peritrichic flagella numbering from four to several. No involution forms were observed in one-month-old fluid cultures. The bacterium is gram negative and non-acid fast. No such species of bacteria has been reported heretofore as the cause of a stem rot of sugar cane. A more detailed description of the disease and the bacillus is in preparation.

E. F. ROLDAN

UNIVERSITY OF THE PHILIPPINES

THE FOUCAULT EXPERIMENT

IN connection with certain studies related to the relativity theory it has occurred to the writer that it might be interesting to repeat the famous Foucault pendulum experiment on a large scale, over a long period of time of perhaps a year or more, and under carefully prepared conditions.

To do so would, of course, require a suitable place and the solution of a number of problems associated with its construction, continuing its motion without affecting its direction, precision of measurement, and others which occur with contemplation. With a pendulum length of 100 feet, for example, rotational motion with a period of more than 2,000 years should be easily detectable over a length of time of a year.

This experiment, if thus carefully performed might reveal or disprove some very intriguing speculative possibilities. It is rather fruitless to outline them but it would seem that a plane of motion for the pendulum perpendicular to the direction of the sun at the earth's perihelion would be a good place to start.

The writer is seriously considering undertaking the task and would be much interested to see opinion, criticism, or suggestion.

MARTIN MEYER

BROOKLYN COLLEGE,
COLLEGE OF THE CITY OF NEW YORK

SCIENTIFIC BOOKS

A History of Applied Entomology (Somewhat Anecdotal). By L. O. HOWARD. Smithsonian Miscellaneous Collections, vol. 84. Washington: Nov. 29, 1930. 564 pp., 51 plates (portraits).

> For the fly, the fly, the fly is on the turmit,
> And it's all me eye, for we to try
> To get fly off the turmit.—*Old Oxfordshire Ballad.*

> The intelligence of the human race, *if brought to bear*, will conquer the insect menace.—*L. O. Howard*, 1930.

IT is probably no exaggeration to say that many thousands of people, at the present time, owe their lives to the work of the entomologists. The greatly increased population of nearly all civilized countries could not be supported without a correspondingly increased food supply, and this we owe in large part to those who have taught us how to defend ourselves against the attacks of insects. Thus, to give a concrete example, there is no orange-grower in California who doubts that his crop would be entirely ruined, were it left to the insects which prey upon it. Within a few years, at most, he would have to go out of busi-

ness, and a product worth about a hundred million dollars a year would have practically ceased to exist. In the discussions concerning the Mediterranean fruit fly, it has not been clearly brought out, but is undoubtedly a fact that it would pay California to spend a million dollars to keep that insect out one year. Not only the enormously increased acreage under cultivation, but the spread of injurious insects from one country to another and the frequent absence of their natural enemies have favored the inordinate increase of many kinds of insects which were formerly harmless. New situations are continually arising in various parts of the world which threaten the prosperity and even the livelihood of whole populations. Not only are the crops attacked, but man and his domestic animals suffer from many diseases which are transmitted through the agency of insects. Malaria, bubonic plague, sleeping sickness, typhus and yellow fever are all transmitted through the bites of insects. Even in warfare it has often been found that insects were the principal enemies, more destructive than the bullets of the opposing army.

I am old enough to remember very well the discoveries of the mode of transmission of malaria and yellow fever, the arrival in America of many pests now prominent, the constantly increasing dangers from insect attack, and the development of means for resistance. As I think of it, we have suffered much from our ignorance and incapacity, from our unwillingness to learn and our lack of organization and cooperation. Yet after all great progress has been made, and the development of the subject, in all its ramifications, is sufficient to amaze those who understand it. Whatever our errors and faults, it still remains true that the work of the entomologists has made possible the existence of great numbers of people for whom, otherwise, there would have been no sustenance, or who would have perished from disease. I said above, many thousands, but doubtless many millions are involved. But in matters of this sort mere statistics are wholly inadequate.

Such a movement, having such great results, deserves to be recorded as history. The ordinary historians know nothing of it, nor are they competent to deal with it had they the wish. Few there are, indeed, who can view it in a comprehensive and intelligent way, and describe it interestingly. Of all men, it was obvious that Dr. L. O. Howard was the best fitted for this undertaking. We may rejoice that his retirement from executive duties has not meant idleness, but fruitful work, the first product of which has just been published by the Smithsonian. It is a history and description of economic entomology, based primarily on the knowledge and experience gained through many years of service: but also, when necessary, compiled from many sources, published and unpublished. It is not, indeed, a perfectly balanced history of the subject, such as may some day be written, because it deals especially with matters familiar to the author. Yet no man has had such wide experience, abroad as well as in America, and nothing could be more appropriate than the description of this experience for us and posterity. Through it, we get the best possible understanding of the essential facts, just as we understand a country better from the well written account of a traveller who has passed through it, than from a portly volume of data on topographical features, populations, trade statistics and the like.

The first part (198 pp.) deals with applied entomology in North America. The second part (138 pp.) describes the work in Europe. Other sections relate to Asia, Africa, Australasia and the Pacific, South and Central America and the West Indies, and medical entomology. The extremely interesting series of portraits includes European celebrities of the seventeenth and eighteenth centuries, fifty-five United States entomologists (three of them women), five from Canada, five from Mexico, and many from other countries. Plate 39 shows five men who are working or have worked in the Hawaiian Islands. In his treatment of the United States, Howard omits the portraits of all the younger men, and very many of them are not even mentioned. He also gives little information concerning the work of many of the experiment stations and other local institutions. On the other hand, the data concerning foreign countries are as complete as it was practicable to make them, and the work of the younger generation is very fully described. Due apologies are made for this onesidedness, and we can readily understand that it was impossible to fully describe all the work going on in different parts of North America without spending additional years and producing another large volume. We in this country may well feel grateful for so much concerning men and measures abroad; but there is a certain danger, very frankly recognized by the author, that foreigners may not adequately appreciate the work of the United States. Thus such books as the "History of Entomology in California," which is being written by Professor Essig, will have their appropriate and very useful place.

In another respect we notice a certain lack of balance, which we have little inclination to criticize adversely. In discussing the events of the past century, and men who have long ago departed from the stage, good and evil are set forth with sufficient frankness to bring out the difficulties and conflicting purposes which so often hindered progress. This was necessary in the interests of historical accuracy, and seems in no case to suggest malice. The very serious faults of C.

V. Riley, Howard's predecessor in office, were well known to all the older men now living, but here they are first clearly described in print. At the same time, no less clearly and emphatically, we are told of the really great things accomplished by Riley, so that when all is said we must recognize him as a potent factor in the development of modern economic entomology. He was the victim of a peculiar temperament, and of political influences which surrounded him, but he had his vision, and was a man of outstanding ability and sagacity. In all these matters, we are inclined to compare him (except as to the politics) with another great naturalist, E. D. Cope.

But to come back to the alleged lack of balance; it consists in this, that whereas long past events are frankly described, all care is taken to avoid hurting the feelings of those now living. Thus the unsophisticated reader might imagine that whereas in the past there was the devil to pay, now virtue, industry and intelligence reign supreme. Who can regret this reticence? Any other course would have been impossible, though I must confess that there are some optimistic passages which I should have omitted. As a matter of fact, while we still have to regret some of the attributes of *Homo sapiens,* it is perfectly true that on the whole the face of things has vastly improved. For one thing, good traditions have been established, which will not readily be broken. Thus heads of departments do not, to-day, coolly appropriate without acknowledgment the work of those under them. Often the tendency is all the other way, and subordinates or students are allowed to publish work which owes its inspiration and much of its originality to those directing them. Crass political influence is not so rampant as it was, and as a rule scientific men have little to fear from it. The public treatment and recognition of entomologists has greatly improved. Public opinion, formed through association in numerous societies, controls the actions of scientific workers so subtly that younger men, coming to the front, would never even think of doing things which once were not uncommon. In short, we are yearly becoming more socialized, and more responsible to one another. In a manner, virtue is forced upon us; or we would prefer to say, our virtues are cultivated rather than our vices.

One very happy movement in which Dr. Howard has had a most prominent part is that for international cooperation in economic entomology. Through many hard experiences, the country has learned that the United States can not live alone in these matters. It seems grotesque that there was once great difficulty in arranging to send a man abroad to study the natural enemies of the cottony cushion scale. Now we maintain laboratories abroad, and it is considered natural and proper that our government entomologists should cooperate in every possible way with those of other countries. It was an occasion for rejoicing when a minute parasite sent from Washington to Italy brought under control one of the most dangerous scale insects of that country. One could wish that politicians and publicists in general might study the international policies initiated and developed by Howard, and become converted to the advocacy of like measures in respect to other affairs. Were this possible, the world would be a much better place to live in.

Special acknowledgment is made in the introduction to the Imperial Bureau (now the Imperial Institute) of Entomology in London and its director, Sir Guy Marshall. This organization serves the whole British Empire, and has attained an extraordinary degree of efficiency. I myself am indebted to it for most of my knowledge concerning the insects obtained during my journeys abroad. Hundreds of these insects, mounted, labelled and named, have been returned to me, and will all go to the larger American museums. Others, new to the British Museum, are retained in London. This kind of efficiency is possible to the Imperial Institute because the vast collections of the British Museum and a large group of skilled taxonomists are available. This work could not have been done in America, or could only have been done with extreme difficulty. The U. S. National Museum has not yet accepted its responsibility for the development of an adequate collection of the insects of the world.

Economic entomology, since the days when Howard and I were young, has not merely undergone tremendous developments, but has taken on new and diverse aspects. It is disconcerting to me to find that I hardly understand many of the articles now published in the *Journal of Economic Entomology.* They seem to me to be chemical engineering rather than entomology. An army of workers is concerned with the enforcement of regulations, the application of insecticides, and other matters wholly foreign to the simple entomologist of old times. The fact is, that different services require different men, and it is not to be expected that any man to-day can be occupied in all the fields of applied entomology. Dr. Howard recurs from time to time in his book to the necessity for fundamental studies, and it is in this respect that we are most deficient. It ought to be possible to produce, through international cooperation, monographs of all those groups of insects which are of prime importance to man. These should not merely describe the cabinet specimens, but should elucidate life histories, habitats, natural enemies and so forth. The ultimate value of such work, from a purely economic point of view, would be very great indeed. Were I to become young again, and get a new start, I think I should wish to be

a taxonomist as I have been, but on much broader lines, including in my studies generic, specific and varietal differences in physiological characters, in responses of all kinds to the environment. The proverbial man in the street, if he knew me and my program, might hesitate to supply the funds, fearing or knowing that I should not have my eye on his bread and butter. The motive force would not be economic, but scientific, no easier to explain than enthusiasm in playing a game. Only on that basis would the rewards come abundantly to the worker, and the pleasure and zeal be maintained. Seek ye first the Kingdom of Heaven, and all else shall be added unto you, may be adopted as the statement of a psychological principle, fully applicable to-day.

It is at this point that we sense the weakest aspect of modern American entomology. There are in Washington and in the experiment stations and universities many capable workers. But as a general thing they are intellectually dissipated by a multiplicity of duties. They may be well paid and not overworked, but they can not concentrate on comprehensive research. Many, no doubt, have long lost any ability they have had for such labors. There has been no adequate policy for the development of comprehensive scientific research in entomology and little training directed toward that end. We have been sorely deficient in imagination, and have supposed that science could be governed by laws of supply and demand.

The book is well and accurately printed, and I find few errors of any kind. Only one suggests comment. Having visited New Caledonia and followed the footsteps of the famous pioneer naturalist of that island, Pére Montrouzier, I regret to see the now important beetle which was named after him printed (in many places) *Cryptolaemus montrousieri*. I have seen this substitution of s for z elsewhere and hope by this comment to stop the too easy propagation of an error in spelling. A criticism of a quite different kind may be added. We regret that there is, among the pictures of the leading economic entomologists of America, none of the dean of them all, Dr. L. O. Howard.

It seems a long time since the eighties of the last century, when, a lone bachelor in a cabin in Wet Mountain Valley, I first entered into correspondence with the entomologists of the Department of Agriculture, and received from Washington a whole sack full of books and bulletins. The letters used to be signed by Riley, but I understand that most of them were written by Howard. The pleasure and instruction derived from them greatly stimulated my zeal and I think it must be said that in that sense the person responsible for much of what I have accomplished since, whether he approves of it or not, is my old friend Dr. L. O. Howard.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO,
BOULDER, COLORADO

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW SPRING BALANCE FOR MEASURING WATER CONTENT OF SNOW[1]

THE water content of snow is determined by weighing a known volume of snow. For example, if a cylindrical prism of snow 1.485 inches in diameter weighs 1 ounce, it contains 1 inch depth of water. To determine the water content of a snow cover a core of snow the full depth of the cover is cut out with a snow tube. This core is weighed, and from its weight the water content is determined.

The problem of weighing the cores in the field under the trying circumstances of cold and storm has presented many difficulties. The fact that measurements of the snow cover must be made on high and almost inaccessible mountains where all travel is on snowshoes or skiis requires a light, portable and convenient instrument for weighing the cores and at the same time one which will give the desired degree of accuracy.

[1] Contribution from department of irrigation and drainage engineering, Utah Agricultural Experiment Station.
Publication authorized by Director, August 7, 1930.

Where large numbers of measurements are made, a balance that can be read directly to 0.5 inch of water and can be interpolated to 0.1 inch of water is of sufficient accuracy.

The snow scales developed by the U. S. Weather Bureau, Church of Nevada, as well as commercial scales that have been used in snow surveying, are all spring scales and subject to the inaccuracies inherent in a spring scale. In addition, they are all dial scales, the purpose of the dial being to give a greater readable accuracy and a wider range. These scales have dials which vary from 5 to 10 inches in diameter. They are heavy, awkward to carry, and are subject to binding when the wind swings the tube which is being weighed.

To overcome some of the disadvantages of the scales now in use for measuring the water content of snow, a tubular spring balance has been developed which is believed to be more sensitive and just as accurate and further has the advantage of being lighter and more compact.

This balance is constructed of drawn seamless brass tubing of such diameter that the spiral spring just fits inside the inner tube and the inner tube fits inside the outer tube with clearance to prevent friction. Over the outer tube is placed a slotted tubular slip joint for setting off zero with the empty tube on the scales. The spring is made of 22- or 24-gauge music wire annealed and tempered. The calibration is placed on the inner tube. To calibrate the balance for a particular diameter of core, the equivalent weight of 1 inch of water in a tube of the same diameter as the core is placed on the spring and the unit stretch determined. The gradations are placed on the barrel of the inner tube by rotating the tube against a sharp tool in a lathe which is adjustable to 0.001 inch.

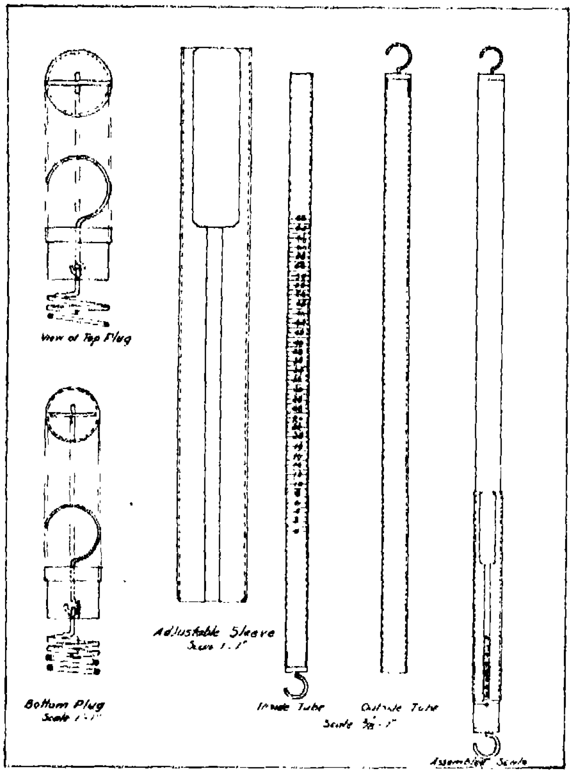


FIG. 1. Parts and assembly of tubular spring balance for measuring water content of snow.

Fig. 1 shows each part of the balance as well as the assembled balance. The hooks are made from 32-gauge piano wire. The plugs are turned out of a bronze rod and the spring is made from 22- or 24-gauge music wire. The drawn seamless brass tubing fits with ample clearance so that there is little friction. The slip sleeve fits the outer tube with spring tightness so that the zero with the empty tube on the scales can be set off. The gauge of wire and diameter of the spiral of the spring will govern the capacity of the balance. A scale having a capacity of 72 inches of water has a distance between each gradation of 0.15 inch. The over-all length of this scale with no load on it is 23 inches; when fully extended it is 41 inches long. This scale weighs 19 ounces. A scale having a capacity of 24 inches has a distance between gradations of 0.21 inch. This scale, weighing only 11 ounces, is 13 inches over all when telescoped and 20 inches long fully extended.

GEORGE D. CLYDE

SPECIAL ARTICLES

COMPARISON BETWEEN IRRADIATION OF DIET AND SUPPLEMENTAL IRRADIATION OF ANIMALS IN VITAMIN A AND D DEFICIENCY[1]

IN an experiment in which eight young rats, about one month old and averaging about 35 g in weight, were placed on a diet that was A-free and low in Vitamin D, on October 14, 1929, and had become well depleted on January 17, 1930, it was found that the addition of 1/100 mgm of irradiated ergosterol daily stimulated their growth for three weeks, but after that time they rapidly succumbed.

In a second experiment (see graph), four lots, consisting of forty-one rats, one month old and averaging 37 gm in weight, were placed on the Sherman No. 380 diet, known to be low in Vitamin D and deficient in Vitamin A, and allowed to become depleted from January 24, 1930. After a period of over eight weeks two of the lots were given irradiated ergosterol, each individual receiving 1/100 mgm daily, mixed with a small quantity of the A-free diet. The other two lots served as positive and negative controls.

RESULTS

The stimulating effects of the Vitamin D thus supplied became quite apparent and lasted for 10 days, then began to subside. The animals in Lot 2 were allowed to exist on the Sherman No. 380 diet, with supplemental Vitamin D, in the form of irradiated ergosterol, but in Lot 1 the animals were also irradiated daily except Sundays, for 30 seconds, at a distance of 18 inches from a Macbeth carbon arc lamp.

Beginning April 28, the additional irradiation was found to markedly stimulate growth for a short time,

[1] Investigations supported by a grant from the National Research Council.

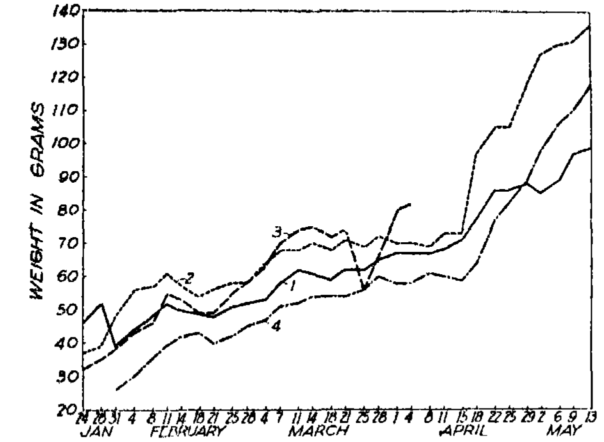


FIG. I IRRADIATED ERGOSTEROL. WITH AND WITHOUT IRRADIATION OF THE ANIMALS

FIG. 1. Lots and Treatment.

1. Sherman No. 380; ergosterol, animals irradiated, April 28.
2. Sherman No. 380; ergosterol.
3. Sherman No. 380; control.
4. Sherman No. 380; cod-liver oil, control.

but did not produce the striking effects on growth and longevity elsewhere described[2] when iodide of iron was added under similar conditions of diet and irradiation.

The chief purpose of our study was of course for comparison with the results obtained with various iodin combinations furnished under the same conditions as in these experiments. It should be noted, however, that the relatively short exposures to ultra-violet light, combined with irradiated ergosterol feeding, did not induce a marked hypervitaminosis.

F. E. Chidester
A. G. Eaton
N. K. Speicher

West Virginia University

HYDROGEN-ION CONCENTRATION OF THE ALIMENTARY TRACTS OF FOWL, CAT AND RABBIT

Investigators of biological subjects have long realized the importance of knowing the chemical reactions of biological fluids. Much critical work has shown the quinhydrone electrode and its many modifications suitable for these determinations.

Both in this country and abroad, determinations of the pH of the alimentary tracts of animals[1] have been made. With these observations in mind and having the necessary apparatus available, the writer has attempted to determine the pH of the alimentary tracts of the fowl, the rabbit and the cat.

Animals used in this work were dispatched in the most rapid and painless manner. In the case of fowls the cervical vertebrae were separated by sudden tension. Rabbits were stunned by a smart blow on the head with a blunt instrument, after which they were bled. Cats were rendered insensible by means of overdoses of chloroform. Their respective alimentary tracts were then rapidly and carefully removed to warm physiological salt solution where they were well washed, following which they were again well washed in several changes of distilled water.

Material taken from several points along the tract was then dissolved in distilled water, filtered and the determinations were made upon the filtrate according to the methods outlined by Clark and Collins.[2] The experiments with fowls were nearly all made in the afternoon after the birds had fed at will. Under these conditions, digestion was in active progress. An average of the results obtained from eight fowls shows the following: proventriculus, 5.59; gizzard, 3.39; duodenum, 6.295; ileum, 6.216; cecum, 1.917. These fowls were altogether upon a grain ration; it is possible that somewhat different results might have been secured had there been some meat in their diet.

The alimentary tracts of the rabbits used in these experiments were all healthy and in the absorptive state. Practically all experiments were made from one to two hours after a full feeding of alfalfa and rolled barley. The averages of determinations upon eight rabbits are as follows: stomach, 1.83; duodenum, 7.35; ileum, 7.99; cecum, 6.26.

Some difficulty was experienced in securing cats, which like rats appear not to thrive very well in this locality. Most of the cats were "tramps" of the wandering kind and appeared quite hungry. Some of them harbored ascarid worms and showed slight intestinal irritation. The averages secured from seven cats were as follows: stomach, 3.34; duodenum, 6.51; jejunum, 6.905; ileum, 6.79; colon, 5.25.

Because of the lack of uniformity in the case of cats, the writer does not consider the data secured as consistent and wishes to present it merely as preliminary. It is interesting to note that the intestinal contents of one cat which had been starved for 24 hours showed great uniformity throughout its entire length. In other cases, although the acidity in the

[2] *Proc. Soc. Exp. Biol. and Med.*, 28: 2, 1930.

[1] Hedon and Bremond, "The pH of the Intestine of the Dog," *Bull. Soc. Med. Biol.*, 7: 484, 1926; C. Schwartz and associates, "The pH of the Stomachs of the Cow," *Pflügers Arch. ges. Physiol.*, 213: 587–592, 1926; Danninger, Pfragner and Schultes, "The pH of the Intestinal Tracts of Horses and Cattle," *Pflügers Arch. ges. Physiol.*, 220: 430, 1928; Grayzel and Miller, "The pH of the Gastro-intestinal Tract of the Dog with Relation to Diet and Rickets," *Jour. Biol. Chem.*, 76: 423, 1928.

[2] Clark and Collins, "The Quinhydrone Electrode and Soil Reaction," *Soil Science*, 24: 453, 1927.

stomach is greater than in the intestine, still the reaction always remains acid in the carnivorous cat as compared with the alkaline reaction in the herbivorous rabbit. Undoubtedly very interesting data might be secured from man, whose diet is of a mixed nature.

SUMMARY

Herein has been presented the results secured in determining the pH of the gastrointestinal tract of the hen, the rabbit and the cat by means of the quinhydrone electrode.

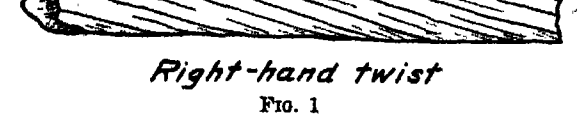
ALVAH R. McLAUGHLIN
UNIVERSITY OF WYOMING

TWIST IN THE GRAIN OF CONIFEROUS TREES

DOUBTLESS many people have noticed that the grain in the trunks of coniferous trees commonly shows a pronounced twist. Perhaps only a few have noticed that this twist is most commonly right-handed. A right-hand screw or helix is one in which clockwise rotation in a nut brings about motion along its axis away from the observer. Such a helix viewed in a horizontal position from the side shows threads sloping from upper left to lower right on the front side as shown in the accompanying sketch.

The writer first observed a preponderant right-hand twist in pine-trees during the field season of 1916 as an assistant with the U. S. Geological Survey in eastern Montana. He recalls making a count of somewhat over two hundred trunks among which were very few showing left-hand twist—not over a half dozen. At that time two or three tentative explanations of the twist were formulated and inquiry made of several botanists as to its cause. No positive explanation was offered. Since 1916 a predominant right-hand twist has been noted in a number of localities, not only in standing and fallen dead trees but also in telephone poles along roads and railroads.

Recently at a locality near the timberline in the Bighorn Mountains west of Buffalo, Wyoming, an exceptional number of bare, fallen trees suggested a careful count of the direction of twist. Four hundred trees, all that showed noticeable twist, were recorded. Three hundred and eighty-four showed right-hand twisting, thirteen had very slight left-hand twists and three showed very strong left-hand twisting. No attempt was made to measure the rate of twist but some impressions may be stated. The majority of the trunks show a twist making a complete turn in ten or fifteen feet. This distance is the *lead* of the terminology of machinists. A few are much more closely twisted, some making complete turns in one or two feet.



Right-hand twist

FIG. 1

In the locality mentioned probably three fourths or more of the trees are noticeably helical in grain. Without the data for actual statistical study the writer gained the impression that the central tendency in these trees was a moderate right-hand twist, and that extreme deviations from this tendency produced a fair number of strongly right-hand examples, a few slightly left-hand ones and very rare pronounced left-hand or closely twisted right-hand examples.

The twisting is not confined to trunks; branches of large size are twisted in some cases and seem to be especially liable to very close twisting. Recent observations at a few other localities indicate that in some places a much smaller number of trees are twisted, and at one place a considerable group of trees appeared to have an excess of left-hand twists. In the main, however, the right-hand twist appears to be far more common. No specific identifications of trees has been made; most of the trees noted in this connection have been pines or spruces. The phenomenon has not been consciously observed in deciduous trees but may possibly occur in some species.

What is the cause of the twist? Why does it show a predominant specific direction and why is that direction right-handed in most groups of trees met with? Several possibilities may be postulated. The twist may be due to a specific set induced in the process of sprouting or some other specific inheritance. Or it might be due to the prevailing counter-clockwise torque resulting from the asymmetrical pressure of prevailing westerly winds on trees with heavier foliage on the south side. Do such trees have asymmetrical foliage and do similar trees in the southern temperate zone show the reverse direction of twist as required by this hypothesis? May topographic control of foliage asymmetries and local anomalies of wind direction explain some of the exceptions noted above?

The above-mentioned facts and suggested interpretations are presented in the hope that others will be able to present more extensive and detailed data and that some reader versed in botany or forestry will offer an accepted or more plausible explanation of the phenomenon.

CHESTER K. WENTWORTH
WASHINGTON UNIVERSITY

SCIENCE

VOL. 73 — FRIDAY, FEBRUARY 20, 1931 — No. 1886

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

A BOTANICAL PROBLEM[1]

By Professor MARGARET C. FERGUSON

DEPARTMENT OF BOTANY, WELLESLEY COLLEGE

"CONSIDER the lilies how they grow." Thus spake the great Master now just nineteen hundred years ago. And this statement from Him is prima facie evidence that the people of this period knew something of plants and of their growth. For it was the habit of this Teacher to base His lessons on the known and familiar. But we have evidence from many other sources that the study and observation of plants was at this time by no means new. When one searches the records for the beginnings of man's interest in and work with plants, one finds the story extending back not only to the earliest days of recorded history but far into those more remote times regarding which the archeologists have as yet found only the most fragmentary evidence, and then on into the mists of the past where conjecture alone can guide us. There is very general belief that the plants of the open plains and of the forests were one, doubtless the most potent one, of the factors influencing primitive man as he started on the long trail upward to civilization and his modern supremacy. We know that Neolithic man grew cereals, raised flax and cultivated plants bearing fruit and nuts. Moreover we find his grains such that they must have been the result of long ages of cultivation and improvement. With those still earlier practices, which must have antedated by many epochs those of Neolithic man, one's imagination may play at will.

Whatever the first abodes of man, whether caves or the sheltering branches of trees, the fact of a more or less fixed habitation, a pausing in his wanderings at some definite point, was undoubtedly a most significant step in that progress which led eventually to man's present estate. We know that two factors

[1] Address of the retiring president of the Botanical Society of America, read at Cleveland, December 31, 1930.

must have been of paramount importance in selecting these stations—the presence of water and land bearing plants suitable for man's need at this time. At first man used only what the land about his temporary abode naturally produced of herbage and fruitful plants. But presently he came to gather seed and to grow those plants which he most desired, thereby reducing or eliminating others for which he had no need. Thus very early in his history man began that ever-continuing process of changing the flora of the lands on which he squatted. When at times he yielded to that roving spirit which was still strong within him, he would move on, and sooner or later he came to take with him seeds of the plants most prized and to plant these seeds about the new habitation in places where each kind of plant would best thrive. This must have been so, else whence came the improved fruits and seeds used by Neolithic man? It thus becomes evident that those prehistoric workers with plants were not only agriculturists, they were also ecologists, a branch of botany so recently organized in its modern form that many of us here present remember when the word ecology was not in the dictionaries. But the fundamental conception of this phase of botany has undoubtedly influenced man's operations since his first feeble reachings out as an economic being. Not only were these primitive peoples agriculturists and ecologists, but we find, very early in the upward climb, indisputable evidence that they were also plant breeders. Neolithic man continued to improve, doubtless unconsciously through selection, the cereals which he inherited from earlier races of men. He seems also to have learned something of anatomy, for in his attempts to satisfy new needs that he came to sense in the early dawn of that higher social life toward which he was groping, we find him cultivating hemp and using the fibers thereof in the weaving of fabrics. It is thus clear that man's first intelligent reactions to the plant kingdom were from the standpoint of what is known as economic botany. Unquestionably his practices were crude and his apprehension slight. But they mark the beginnings of the growth of our knowledge of plants along some of the most important lines of botany extant to-day. To be sure there were, so far as we know, for long ages after man became interested in using and cultivating plants, no organized schools or centers for the dissemination of knowledge. But must we therefore conclude that man's mind during this period was totally untrained? We are too prone to accept the idea that "all learning is confined within our academic halls." There is another and I venture to think a greater school—the school of experience. And it was in this school that man learned his first lessons in botany.

Most historical writers of the subject during the last century place the beginnings of botany with the writings of Aristotle and Theophrastus. We would not discredit their contributions, but if we accept theirs as the beginning what shall we do with such evidences as those already referred to, or with those other records which indicate that the Egyptians were intelligent observers and growers of plants more than 3,000 years before Christ? What of those interesting slabs which depict King Ashur-nasir-pal and his attendants, almost a thousand years before Christ, artificially pollinating the date palm and thus apparently appreciating, and for all that we know understanding, something of the fact of sexuality in plants? And again there are the descriptions of plants written by Hippocrates, an early taxonomist, who was over seventy years old when Aristotle was born. Have not these and other studies and practices with plants, that might be mentioned, as just a claim to recognition by botanists as have Aristotle's more philosophical writings regarding plants? This great scholar passes over the idea of sex in plants with the statement that it is against their nature, thus ignorant of or ignoring the practices of the early Assyrians as illustrated in those bas-reliefs, just referred to, which are now in the British Museum.

The answer to these questions depends naturally on what one means by the term botany. If one consults various dictionaries, encyclopedias, histories of botany and etymological works, one finds two very distinct conceptions as to just what the word connotes. Certain of us would accept Professor A. B. Rendle's definition, as recorded in the Encyclopedia Britannica, that "Botany is the science that includes everything relating to the vegetable kingdom." This is practically in accord with, though less explicit than, the description of the subject to be found in the New Standard Dictionary. Here botany is defined as "the science which treats of plants," and is divided into eleven, apparently coordinate, branches. Among the branches recorded is economic botany, which the writer says "includes agriculture, forestry, horticulture, floriculture, and cognate subjects." Surely one could not hope for any conception more all-inclusive than are these. Others of us, and I suspect the larger group, would accept the view most frequently given and well illustrated by Professor Coulter's description of botany as outlined in the New International Encyclopedia. He places the beginnings of what he calls "scientific" botany with the classification of plants, citing Hippocrates as the first writer or student of "scientific" botany. He states that botany has become a very diversified subject, but, according to the classification which he gives, he would limit the use of the term to those aspects of the subject

which have no immediate application whatsoever to problems of utility. That is, he would make botany strictly a pure science and relegate all phases of the science which are directly concerned with practical problems to other, or what he calls "related" sciences, as agriculture, horticulture, etc. It would appear then that we have among botanists in general, as have the taxonomists, the "lumpers" and the "splitters."

There is fairly good evidence which I shall not attempt to detail here that up to the sixteenth century, botany included, as Rendle says, "everything relating to the vegetable kingdom." At the same time it is evident that the great diversity of approaches to the subject, its many-sidedness, were fully recognized long before the beginning of the Christian era; and that it very early became divided, *not broken up,* into several branches. To this day the branches are increasing in number and the number will continue to increase as modern research extends the boundaries of botanical science. The educational value of those branches which deal with the more practical aspects of the subject were early recognized in formal education. Chrysippos, of the School of Cnidus, wrote a book in the fourth century B. C. on the various kinds of vegetables grown in the garden of the school at Cnidus. And a little later we find Theophrastus basing many of his conclusions on observations made in the botanic garden of the Aristotelian lyceum. He further records his discussions in the classroom regarding the significance of grafting, budding and other horticultural problems. Much later, about 1650, we hear the great educator, Comenius, declaring that there should be gardens in connection with the universities that the sons of noblemen might be trained in the art and science of horticulture. Such was the broad field covered by botany from the earliest time. But about 1600 there began, in certain quarters, a slow but effective process of reduction in the scope of the subject-matter included in the science of botany. In his classical history of botany, Sachs speaks of the botanical writings of Aristotle, Theophrastus, Pliny and Dioscorides. But he places the foundations of modern botany in the sixteenth century with the works of Brunfels, Bock and Fuchs, and in this year (1875) he divides the science of botany into three great departments—morphology and classification, vegetable anatomy, vegetable physiology. Botany, then, at this time is strictly a pure science shorn of all applied phases or branches included in the earlier conceptions of the botanical field. Strictly economic in its beginnings, it is, as discussed by Sachs, no longer in any sense a humanistic subject.

As one contemplates the history of our science from its first inception to the present day, one is forcibly reminded of that remarkable theory of evolution formulated by Empedocles. It will be remembered that in the century before Aristotle he conceived of a method of evolution which consisted first in the establishment on the earth of fairly complex plants. Then there followed a budding off from these plants of parts of organisms, now one part and now another—arms, legs, trunks, ears, eyes, and whatnot, sent off into space. These ejected parts, however, did not remain isolated but tended to come together and to unite. In this reassembling very grosteque animals were built up. Witness the centaurs of Greek mythology. But these misfits were unable to reproduce and hence their kind was not perpetuated. After many trials, animals fit to survive and therefore capable of reproduction were formed. So during the latter days of the Renaissance, or about the close of the sixteenth century, when the science of botany was fairly well established and had sent its branches out in many directions, a budding-off process began. This reached its climax, let us hope, in the latter part of the last century. First one branch and then another became detached until the subject was so depleted or reduced in scope that in the opinion of many to include in the concept of botany, or to refer in the teaching of botany to anything that was grown in the field or that smacked in any way of the nearby and familiar was to debase the pure science of botany.

During the very last years of the last century there were here and there signs that the later stages of the process outlined by Empedocles, that of reassembling the severed parts, was setting in. It began to look as if botanical science was not only to be restored to its primordial scope but, as a result of the unparalleled development of all its parts during the century, it was to take a more significant place among the physical sciences than had heretofore been allotted to it. But, alas, the movement did not project itself into the new century with the vigor that some had anticipated. To-day those who believe in the more comprehensive organizations are more or less quiescent while here and there the budding off continues and it has not stopped with the various phases of applied botany. The tendency at present, however, is not so much a budding off as the result of normal growth, but rather a deliberate self-severing of the buds, perchance those of pure botany—too often it is feared neither to the advantage of the parent stock nor to that of the scion or severed branch.

I well remember the white rage, I know no better phrase to express it, with which one of our most highly esteemed botanists observed in 1900 certain

illustrations in an elementary text-book of botany that had just come from the press. These illustrations were some of the first evidences of a tendency among certain botanists toward reunion. On two pages of the open book there appeared on one a drawing of a properly clothed man's leg, from the knee down, with the trousers well covered with various kinds of hooked and barbed fruits and seeds; and on the opposite page was to be seen a picture of the posterior portion of a cow's body with the tassel of the tail filled with burdocks. "Such a cheapening of our science was not to be tolerated. It was coarse and disgusting." But I submit, what better illustration of the dissemination of fruits and seeds by means of the clothing of animals could Professor Bailey have found? Had he used the picture of a wild lion tearing through the forest with its tail and mane well filled with the fruits of *Harpagophytum procumbens* and a drawing of the orang-outang striding forth with the fruits of *Durio zibethinus* in his hands and various burs of his native haunts clinging to his hairy body; I am positive our distinguished protector of pure botany would have been entirely satisfied, yes, delighted. At about this time another leading botanist of the period was heard discussing with concern the fact that certain practices from the field and garden were creeping stealthily into our college class-rooms. And he warned his hearers that this must be guarded against for eventually it could mean nothing less than a lowering of standards. Such were the extreme "splitters" at the close of the last and the beginning of the present century.

Undoubtedly there are many to-day who feel that such a view-point is justifiable. But were it best at this time, I believe arguments could be presented to show that largely because of this narrower view the science of botany has failed, in a degree, to measure up to the large place which it should hold in modern life and thought. When one compares the field of botany, using the term in its broadest sense, with that of other disciplines, one is inevitably led to the conclusion that the subject-matter of no other department of knowledge is more significant in its relations to human life and progress, is more multisided in its appeal or presents a greater challenge to the intellect or to the imagination. But these values can be fully realized only when there is the greatest possible co-operation between its several branches, and the subject stands in the solidarity of organic union of all its parts. The whole realm of the plant kingdom is intrinsically one. No part can be segregated without mutual loss to all. The problem that confronts botany in the twentieth century is inherent in the very nature of the subject itself. It is inevitable that so diversified a field should have a tendency to break up into smaller units. As a result of this very natural tendency, botany is to-day so split up into parts, each trying to stand alone, that she falls somewhat below the high place that is rightfully hers among the scientific stars of the first magnitude. You recall the story of the day laborers who were asked what they were doing. One replied, "I am cutting stone," another, "I am carving wood." Both facts were perfectly obvious to the questioner. But a third, the man of vision, answered with pride, "I am building a cathedral." Even so, when cordial and vital unity has been established among all members of the botanical body, may the student of plants say in lofty and justifiable pride, "I am a botanist. I am helping to make the world better."

That the lines of cleavage that have been set up are largely artificial is constantly becoming more and more apparent. I listened one day at the *Horticultural* Congress in London last August to two very interesting papers. These papers lost something of their interest for me when I heard them again, given so far as one could judge in the hearing, verbatim, the following week before the *Botanical* Congress meeting in Cambridge. A survey of the programs of the two congresses suggests that these were doubtless not the only instances of repetition. Why then two congresses? Applied and pure botany—can we separate the two? It is a commonplace that the discoveries in pure science to-day become the practices of the shop and of the field to-morrow. But is their value thereby lessened? There seems still to linger with us that "ancient fear of humanizing knowledge." But is not one of the glories of botany the fact that it is constantly making the world a better place to live in? The time is ripe, yes, overripe, when we scientists should abandon, wholeheartedly, the academic tradition that "polite learning and true culture admit no contact with utility."[2] But this is not all, there is another and even more pernicious tendency which is increasingly evident among us. It has nothing to do with utility or applied science. It strikes deep into the roots of the botanical tree. I refer to the breaking-up of pure botany itself into independent non-affiliated groups. Such a process must eventually spell disintegration all along the line.

May I reiterate, we in botanical science shall find our greatest power in the largest unity—a union in organization and in spirit. Let us be parasitologists, pomologists, mycologists, algologists, dendrologists, thremmatologists or any other sort of a botanical ologist, but let us first be *botanists*. The hand can

[2] C. M. Woodward, Science, December 28, 1906.

not do the work of the eye nor the eye of the foot. Neither can these several organs perform each its own function except as properly joined to the body by means of which they are correctly assembled and their activities coordinated. In like manner should the various branches of botany be united in one great central body—this body big enough, and strong enough, and flexible enough not only to include every phase of botany but to give freedom and inspiration to every one of its numerous ramifications. Such an organization I believe we already have in the Botanical Society of America. If not let it be so changed that it may be fit for the larger responsibility. Or if best discard it, which let us hope will not be necessary, and build up a new organization under whose banner all may enlist. Every student of plants should then be first a member of the great all-inclusive parent organization and secondly a member of the section or branch wherein his own particular field of endeavor lies. Thus united we shall stand in the power and dignity that so great a science deserves; but separated, we shall ever fail to measure up to the high destiny that may be ours. I repeat Professor Arthur's statement made in an address given before this society just ten years ago. "The botanists' realm is the vegetable kingdom."

Is not this then our theme this evening? The scope of botany, unrivalled by that of any other science, and botanical unity. Only, we believe, by the force of such a unity as has been suggested shall botany fulfil, in largest measure, its high mission in the commercial, the intellectual and the cultural life of the world. It is to this larger fraternity that I would call every student of plant life.

HERBERT HOOVER AND SCIENCE

By Dr. VERNON KELLOGG

PERMANENT SECRETARY, NATIONAL RESEARCH COUNCIL

As a boy preparing for college Herbert Hoover decided to go to a university which paid especial attention to science. He went to Stanford University, took major courses there in geology and mining, graduated in 1895, and began at once a successful career as mining engineer. This lasted up to the beginning of the World War, when he gave it up and became known to all the world as relief worker, Food Administrator, Secretary of Commerce, and President of the United States. In all these capacities he has shown a notable appreciation of science and the scientific method, and he has helped materially to support and extend scientific knowledge.

As mining engineer in charge of very large enterprises in Australia, China, Burma, the Ural Mountains, Mongolian Siberia, South Africa and elsewhere he attacked with success various scientific mining and metallurgical problems. Most notable, perhaps, was his success in Australia in advancing the flotation process and in working out means of profitably recovering the zinc content from low-grade silver ores.

In the prosecution of his large mining operations he successfully met important social problems arising from the gathering together of communities of thousands of workmen and their families in parts of the world distant from civilized regions. His great Kyshtim project in the Ural Mountains, for example, maintained a community of 70,000 people who were lifted by him through his scientific and social work from poverty and squalor to a high state of comfort and prosperity.

He is the author (with specialist collaborators) of "Economics of Mining," published by the *Engineering and Mining Journal*, New York City, 1905; also of "Principles of Mining," 199 pp., 1909, McGraw-Hill Book Company, used in mining schools; also of "De Re Metallica," by G. Agricola, founder of the modern science of mineralogy, translated by Mr. Hoover and his wife from the first medieval Latin edition of 1556. To the original text the translators added an important biographical introduction and an invaluable host of annotations and appendices about the development of mining law and mining and metallurgical methods from the earliest times to the sixteenth century. He also is the author of numerous addresses and papers published in mining and engineering magazines and elsewhere. He has lectured on engineering at Stanford and Columbia Universities, and has been president (1920–1921) of the American Institute of Mining and Metallurgical Engineers; president (1920–1921) of the American Engineering Council (federated American engineering societies); chairman of the Advisory Committee of the Food Research Institute, Stanford University (1921–); president (1927) of the International Radiotelegraph Conference; trustee (1920–) of the Carnegie Institution of Washington; trustee (1912–) of Stanford University, and officer or member of various other major national engineering and scientific societies and organizations.

He has been given honorary academic degrees by twenty-five universities, and has been awarded the following medals for scientific merit:

1914—Mining and Metallurgical Society of America—gold; jointly with Lou Henry Hoover for "distinguished contribution to literature of mining." ("De Re Metallica.")

1920—National Academy of Sciences—for "eminence in the application of science to the public welfare."

1928—American Institute of Mining and Metallurgical Engineers—for "achievement in mining."

1929—John Fritz Gold Medal—awarded jointly by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers for notable scientific or industrial achievement.

In 1902 he was elected member of the American Association for the Advancement of Science, and fellow in 1915. On the occasion of the meeting of the association in Philadelphia in December, 1926, Mr. Hoover made a notable and largely attended public address ("The Nation and Science") in which he emphasized energetically the importance to the nation of science, and urged strongly the support by the people of this country of "pure" or fundamental science as a necessary basis for continuing advance in applied science.

> No greater challenge has been given to the American people since the great war than that of our scientific men in the demand for greater facilities. It is an opportunity to again demonstrate in our government, our business, and among our private citizens the recognition of a responsibility to our people and the nation greater than that involved in the production of goods or trading in the market.

He delivered a similar address ("The Vital Need for Greater Financial Support to Pure Science and Research") before the American Society of Mechanical Engineers in December, 1925. In this address he made the following statement:

> The far-sighted leaders of industry fully recognize the dependence of their progress upon advances in science, and emphasize their belief that fundamental research should be much more greatly aided. . . . We have prided ourselves on our practicality as a nation. Would it not be a practical thing to do to give adequate organized financial support to pure science? If, by chance, we develop a little contribution to abstract learning and knowledge, our nation will be immensely greater for it.

In 1922 he was elected member of the National Academy of Sciences, and in November, 1925, accepted the active chairmanship of a special board of eminent scientific men and outstanding men of public affairs set up by the National Academy to attempt to establish a National Research Fund of several million dollars for the support of work in fundamental science. Mr. Hoover took an active personal part in the work of obtaining pledges for this purpose from large industrial organizations and wealthy men of this country. The amount already pledged is at least five million dollars, with contingent possibility of another five.

As Secretary of Commerce and President he has made an impressive record in bringing about ever increasing support and extension of the work of the government's scientific divisions and bureaus. He became Secretary of Commerce in March, 1921. In the past ten years the appropriations for the support of the (primarily) scientific bureaus of the department have increased as follows: Bureau of Standards, from \$1,354,632 to \$3,485,671; Bureau of Fisheries, \$1,291,-810 to \$2,640,560; Bureau of Mines, \$1,302,642 to \$2,729,480; Coast and Geodetic Survey, \$2,316,317 to \$3,020,104.

It was as a result of his vigorous championship that the establishment of a great National Hydraulic Laboratory (\$350,000) at the Bureau of Standards was brought about.

He has been active in having formulated, adopted and enforced various important fish conservation measures based on careful studies by leading scientific fisheries experts of the country. In this connection have been established, under his active sponsorship, an Upper Mississippi River wild life and fish refuge; a Northern Pacific Halibut Convention with Canada, and a generous five-year construction and maintenance program for the Bureau of Fisheries, with special support for its strictly scientific work. He also obtained, after an active struggle, authority for the Secretary of Commerce to say when, where and how salmon and other fishes were to be taken in the waters of Alaska. In exercising this authority, Mr. Hoover placed great dependence on the advice of the late Dr. C. H. Gilbert, one of the country's greatest fishery scientists, as well as his assistant in charge of salmon research, Dr. W. H. Rich.

The Bureau of Mines, transferred in 1925 from the Department of the Interior to the Department of Commerce, was enabled, with the active sponsorship of the Secretary of Commerce, to expand materially its scientific investigations of fundamental problems in the extraction of shale oil and in the extraction of potash from ores occurring in the various parts of the United States.

Mr. Hoover's special interest in aeronautics led to large expansion of the scientific work of the aeronautics branch of the Department of Commerce. The total appropriation for the work of this branch in the year 1927 was \$500,000, while in the year 1929 it was over \$5,000,000. With this large increase in

funds available, the division was able to develop a comprehensive and far-reaching constructive research program.

While Mr. Hoover was Secretary of Commerce, radio broadcasting was begun. He took great interest in the scientific development of radio and realized the future possibilities of broadcasting. He presided over four national radio conferences and took a lively interest in the proceedings of the International Radio-Telegraph Conference held in Washington in 1927.

In 1925 Mr. Hoover negotiated the transfer of the seismological investigations from the Weather Bureau of the Department of Agriculture to the Coast and Geodetic Survey in the Department of Commerce. A direct attack is being made by the survey on the problem of obtaining complete information about all earthquakes occurring in the United States or regions under its jurisdiction, and special investigations are being conducted to discover fundamental facts which may be made available to engineers and builders in connection with building for earthquake resistance. The Coast and Geodetic Survey undertook a survey of the Mississippi River area from Cairo to New Orleans, thus making available basic data touching fundamental problems of flood control.

Mr. Hoover has shown his special interest in promoting scientific care of child health and protection by his organization in 1922 of the American Child Health Association, of which he was the first president, and by the organization of the White House Conference on Child Health and Protection.

But a catalogue of the scientific undertakings encouraged and materially supported by Secretary and, later, President Hoover would be a long one—much too long a one to print here.

As Secretary of Commerce and President, Mr. Hoover's relation to scientific work has been that of encourager, supporter and administrator, necessarily not that of laboratory or field man. As such supporter and administrator of science he has made much and great scientific work possible; and for this he should have the gratitude of scientific men.

What President Hoover said of Dr. W. H. Welch in his impressive address at the celebration, in April, 1930, of Dr. Welch's eightieth birthday may well be said of Mr. Hoover:

> Our age is marked by two tendencies, the democratic and the scientific. In Dr. Welch and his work we find an expression of the best in both tendencies. He not only represents the spirit of pure science but constantly sees and seizes the opportunities to direct its results into the service of humankind.

OBITUARY

MEMORIALS

THE centenary of the birth of James Clerk Maxwell is to be celebrated in the University of Cambridge on October 1 and 2, following on the Faraday celebration and the centenary meeting of the British Association in London. Addresses are to be given at Cambridge by Professors Einstein, Langevin, Larmor, Planck, Sir James Jeans and Sir J. J. Thomson.

As its contribution to the celebration of the hundredth anniversary of the discovery of electromagnetic induction by Michael Faraday in England and Joseph Henry in America, two lectures have been given at the Massachusetts Institute of Technology. Faraday was the subject of the first lecture, which was given on February 13 by Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, and Dr. W. F. Magie, Henry professor of physics, emeritus, of Princeton, lectured on February 18 on the life of Joseph Henry. Both lectures were open to the public.

THE Hunterian Society of London commemorated the two hundred and third anniversary of the birth of John Hunter by a banquet at the May Fair Hotel on February 19.

AT a recent meeting of the Board of Health of New York City the following resolutions were adopted:

> WHEREAS, Dr. Charles Krumwiede, an assistant director in the Bureau of Laboratories, has passed to the great beyond at the early age of fifty-one years, and
>
> WHEREAS, Since his connection with the laboratory in 1909, Dr. Krumwiede was an invaluable, resourceful and most painstaking worker, and
>
> WHEREAS, His studies on the types of tubercle bacilli, on bacilli of the typhoid-colon group, on psittacosis and on many other important bacteriological problems added lustre to the work of the Bureau of Laboratories, be it therefore
>
> *Resolved,* That the Board of Health record on its minutes its very great appreciation of the work of this distinguished scientist and its great sorrow at the passing of so talented an investigator and able administrator, and be it further
>
> *Resolved,* That a copy of these resolutions be sent to the bereaved family with an expression of the board's deep sympathy in its irreparable loss.

RECENT DEATHS

DR. VERANUS A. MOORE, from 1908 to 1929 director of the New York State Veterinary College at Cornell University, died on February 11, at the age of seventy-two years.

HANDEL T. MARTIN, assistant curator of the University of Kansas Museum of Paleontology, died in Lawrence on January 15. He was sixty-eight years old.

JOHN H. LIGGETT, assistant professor of psychol-

ogy in the University of California at Los Angeles, died on February 10 following an operation.

SIR ANDREW BALFOUR, director of the London School of Tropical Medicine, died on January 29, at the age of fifty-seven years.

PROFESSOR ARCHIBALD LEITCH, director of the research department of the Cancer Hospital, Fulham, London, died on January 2, at the age of fifty-two years.

DR. M. W. BEIJERINCK, the Dutch bacteriologist, known for his many valuable contributions to microbiology, died at his country home at Gorssel, Holland, on January 1, at the age of seventy-nine years.

PROFESSOR GEORGE WEISS, formerly dean of the Faculty of Medicine at Strasbourg, died on January 24. A correspondent states that "Professor Weiss was an important figure in the decade following the armistice, since he was entrusted with the deanship and the organization of the French Medical Faculty at Strasbourg."

FEDERIGO GUARDUCCI, until his retirement professor of theoretical geodesy in the University of Bologna, died on February 7, at the age of eighty years.

DR. C. Y. WANG, professor of pathology in the University of Hongkong, died on December 16 after an illness of some months at the age of forty-two years. Dr. Wang was a fellow of the Royal College of Physicians of Edinburgh.

SCIENTIFIC EVENTS

MUSEUM SPECIMENS

AN exhibition has been held in London of museum specimens specially prepared for rural areas. According to the account in the London *Times*, the display was arranged by the Museums Association (aided by a grant from the Carnegie United Kingdom Trust) to synchronize with the annual meeting of the Association of Directors and Secretaries for Education. Sample exhibits arranged for circulation to schools were lent by various American institutions, as well as by a number of museums in England.

The Liverpool collection, of which a nucleus began to be formed for circulation to 64 schools in 1884, is an example of pioneer work. During the years in which the exhibits have grown their sphere has also been extended, so that some 136 schools (not all within the city boundaries) are now drawing on the collection. Some of the cases have seen hard service, and the newer models among the cases are lighter and better arranged; thus pictures and tools representing the men of the Early Stone Age appear manageably together, and the plumage of birds is sent round in a light tube for special study.

A different method is used by the Bagshaw Museum and Art Gallery, administered by the Batley Corporation; this institution uses light folding boxes, each containing 20 specimens, to illustrate some single branch of knowledge. Each specimen is in a small transparent circular container, designed to be handed round to the children of the class with an appropriate label. This scheme has been applied during the past nine years to the service of 17 elementary schools, and has extended the range of subjects rapidly on a grant of only £20 a year.

The portable exhibits of the Tolson Memorial Museum have been designed to provide knowledge of general subjects through local examples, which are very varied, in the field of geology and the natural sciences, as well as in past rural industries and ancient monuments. Special maps have been made for circulation by the museum to illustrate the local geographical distribution of natural and historical features, and a scheme is coming into operation whereby the main branches of study can be radiated outside the county borough through eight rural centers to a more numerous range of villages.

A still more ambitious scheme of circulation is that provided within the past 12 months by the Leicester Museum and Art Gallery, which adds to its series of small traveling cases of antiquities and local natural history a series of framed water-colors, prints and drawings, which are equally available for circulation to rural communities, not necessarily schools.

Most of the other museums represented in the exhibition follow one of the general plans mentioned above. But the large-scale dissections of botanical and zoological specimens sent out for the past 15 years by the Dorman Memorial Museum, Middlesbrough, and the essay scheme on local natural history with which the Perthshire Museums accompany a circulation scheme, now 30 years old, are said to deserve commendation. The City of Salford shows some large tableau cases, and the Reading Public Museum has a display illustrating through some 46 specimens (all of which go into a small dispatch case) the natural, industrial and scenic resources of Canada.

The American contributions largely duplicated some of the British displays, but the automatic motion-picture projectors from the American Museum of Natural History and the miniature human figures

lent by the Buffalo Museum of Science are noted as of great interest.

FIELD MUSEUM OF NATURAL HISTORY

More than two million persons received direct educational benefits from the Field Museum of Natural History during 1930. Of this number, 1,332,799 were visitors to the museum, while more than 716,000 were school children who participated in the extra-mural activities conducted by two special units of the museum organization—the N. W. Harris Public School Extension which circulates traveling natural history and economic exhibits to schools and community centers, and the James Nelson and Anna Louise Raymond Foundation, which provides lecturers, motion pictures and other means of supplementary education.

The 1,332,799 persons visiting the museum itself represented an increase of 164,369 or more than 14 per cent. over the previous year. Of these, approximately one third were children, according to Mr. Stephen C. Simms, director of the museum. It is of interest to note that of the total number of visitors, only 160,924 paid the 25-cent admission charged to adults on Mondays, Tuesdays, Wednesdays and Fridays; while 1,171,875 persons were admitted free of charge, this including those attending on Thursdays, Saturdays and Sundays, the free days, and all the children who are admitted free every day.

The activities of the Harris Extension reached more than 500,000 children in 430 schools and other gathering places. Those of the Raymond Foundation, including both programs presented in the museum and those presented in the schools, reached 277,245 children. For adults, twenty-seven illustrated lectures on science and travel were presented, and in addition, various series of guide-lecture tours, which attracted a total attendance of 37,031.

The election by the board of trustees of Field Museum of two new honorary members of the museum, and one patron, are announced by Stephen C. Simms, director. Mr. Arthur S. Vernay, of New York and London, and Mrs. E. Marshall Field, of New York, are the honorary members, elected in recognition of their eminent services to science. Mr. Philip M. Chancellor, formerly of Chicago and now a resident of Santa Barbara, California, is the patron, elected in recognition of eminent services to the museum. Mr. Vernay financed and led the Vernay-Lang Kalahari Expedition for Field Museum last year. This expedition brought the museum a vast zoological collection of African mammals, birds, fishes and invertebrates, numbering several thousand specimens, and also important botanical and ethnological collections.

Mrs. E. Marshall Field has long manifested a deep interest in science, and has actively participated in scientific work in the interest of the museum. Several years ago she was a member of a Field Museum expedition which made large collections of botanical, geological and zoological material over a wide range of South American territory. Mr. Chancellor has financed and led two museum expeditions, the Chancellor-Stuart Expedition to the South Pacific (1929–30), and the Chancellor-Stuart Expedition to Aitutaki, Cook Islands (1930). Both of these brought the museum valuable zoological collections.

LATIN AMERICAN FELLOWS OF THE GUGGENHEIM FOUNDATION

The trustees of the John Simon Guggenheim Memorial Foundation announce the appointment of seven fellows from Argentina and Chile who will come to the United States in the course of the next few months to carry on advanced work and research in various fields of knowledge. These fellows are the first to be appointed from Argentina and Chile as Latin American fellows of the foundation.

Established in 1925, the foundation, for a time, made its grants for work abroad only to citizens or permanent residents of the United States, but two years ago former U. S. Senator and Mrs. Simon Guggenheim, the founders of the fellowships in memory of a son who died in 1922, added a one-million dollar endowment to set up a plan of Latin American Exchange Fellowships to be additional to the work of the foundation in the United States, already endowed with their gift of $3,500,000. Mexico was first included in the new plan and, with this announcement, its benefits are extended to Argentina and Chile.

The foundation had announced that this year two fellowships in each country would be granted in Argentina and Chile. Induced however by the large number and high quality of the applicants in each, four were granted in Chile and three in Argentina.

The Latin American fellowships of the foundation are planned as an exchange of scholars between the countries of the two Americas, and Senator Guggenheim has said: "We are proceeding in the conviction that we have much to learn in those countries that are our elder sisters in the civilization of America and much to give their scholars and creative workers. That is fundamental to our thinking on this subject."

In accordance with these plans scholars from the United States who plan to work in Latin America will be selected in this country in March, and at that time fellows from Mexico and Cuba will also be chosen. The Latin American fellows of the foundation just appointed are the following:

From Chile:—Eduardo Bunster Montero, School of Medicine, University of Chile, will carry on studies in the physiology of certain glands of internal secretion at Harvard University. Manuel Elgueta Guerin, Genetics

Division of the Experimental Station of the National Agricultural Society of Chile, will study the application of genetics to the improvement of plants at Cornell University. Joaquin Monge Mira, professor of geology in the Catholic University of Chile, will work on problems of harbor improvement and flood control. Genaro Moreno Garcia-Conde, professor of mathematics in the School of Military Engineering of Chile, will undertake mathematical research, especially in the theory of functions of real variables.

From Argentina:—Salomon Horowitz, chief of the Institute of Genetics of the University of Buenos Aires, intends to carry on studies in cytology and genetics. Homero Mario Gugliemini, a writer of Buenos Aires, will study the principal currents of philosophy in the United States. Carlos Garcia Mata, of the Department of Finance and Public Works in the Province of Santa Fé, Argentina, will study, at the Harvard Graduate School of Business Administration, methods of predicting economic phenomena.

These Latin American fellowships of the foundation are granted on terms generally similar to those governing the John Simon Guggenheim Memorial Fellowships in the United States. They are open to men and women, married or unmarried, without distinction of race, color or creed. Fellows from the United States to Latin America, or from Latin America to the United States, are not restricted in choice of university or other place of study.

The stipend for these fellowships, either for Latin America or for the United States, is $2,500 a year plus a travel allowance. The fellowships are awarded in the first instance for one year, but with the possibility of renewal.

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

The Board of National Research Fellowships in the Biological Sciences, which includes within its scope the fields of anthropology, psychology, botany, zoology, agriculture and forestry, held its first meeting in 1931 on January 31 and February 1, and made twelve reappointments and seventeen new appointments for the academic year 1931–32, as follows:

REAPPOINTMENTS

For domestic study:

O. D. Anderson—psychology
L. W. Gellermann—psychology
E. Harold Hinman—zoology
Ancel B. Keys—zoology
R. K. Meyer—zoology
Elsa R. Orent—biochemistry
Daniel Raffel—zoology
Hugh M. Raup—botany
Gene Weltfish—anthropology
Samuel Yochelson—psychology

For study abroad:

George Kreezer—psychology
T. L. Steiger—agriculture

NEW APPOINTMENTS

For domestic study:

G. W. Adriance—agriculture
S. H. Bartley—psychology
Lyman C. Craig—agriculture
S. T. Dexter—agriculture
Clarence H. Graham—psychology
S. R. H. Hall—zoology
E. W. Hopkins—agriculture
Burt P. Johnson—botany
Samuel L. Leonard—zoology
Marion L. Lohman—botany
B. F. Skinner—psychology
Frederick K. Sparrow, Jr.—botany
Raymond G. Stone—zoology
F. P. Zscheile, Jr.—botany

For study abroad:

H. H. Jasper—psychology
Victor C. Twitty—zoology
Wm. Caldwell Young—zoology

The second meeting for further appointments for 1931–32 is planned for about April 30 and May 1, and applications for consideration at this meeting should be filed not later than March 15. Information and application forms may be obtained from the Secretary, Board of National Research Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

FRANK R. LILLIE, *Chairman*
BOARD OF NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

THE INDIANAPOLIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

The eighty-first meeting of the American Chemical Society will be held in Indianapolis from March 30 to April 3. New knowledge of life processes in both health and disease through the systematic use of chemistry will be a chief field of discussion. More than 1,500 men and women of science are expected to attend.

The opening event, according to the preliminary program, made public by Secretary Charles L. Parsons, will be a meeting of the council at 2 P. M. on Monday, March 30, the president of the society, Professor Moses Gomberg, of the University of Michigan, presiding.

Three symposiums will be given on March 31. One, on "Contemporary Developments in the Chemistry of Physiologically Active Substances," under the auspices of the Divisions of Biological, Medicinal and

Organic Chemistry, with Professor James B. Conant, of Harvard University, as chairman.

A second symposium, on "Cooperation between Industry and Chemical Education," will be sponsored by the Division of Chemical Education, of which Dr. John N. Swan, of Tuckahoe, New York, formerly head of the department of chemistry in the University of Mississippi, is chairman. Teachers from high schools and colleges all over the United States will participate. Exhibits from high-school chemistry classes in many states will compete for prizes. There will also be an exhibition of chemical apparatus and products by manufacturers. On April 1 the Senate of Chemical Education, composed of representatives of education and industry, will convene to receive reports of committees. On April 2 the members of the division will attend the dedication at Bloomington of the new chemistry building of the University of Indiana.

A third symposium, on "Mathematics in the Service of Chemistry," will be given by the Division of Physical and Inorganic Chemistry, of which Professor Farrington Daniels, of the University of Wisconsin, is chairman.

"Dietary Facts and Fads" will be the subject of a public address at 8:30 P. M. on April 1 by Professor William C. Rose, of the University of Illinois. The Divisions of Gas and Fuel Chemistry, Industrial and Engineering Chemistry, and Petroleum Chemistry will combine in joint sessions on the "Utilization of Gaseous Hydrocarbons." New and unpublished research work at agricultural experiment stations will be reported at a meeting of the Division of Agricultural and Food Chemistry, headed by Professor James S. McHargue, chief chemist of the Kentucky Agricultural Experiment Station at Lexington.

The Division of Cellulose Chemistry, Frederick Olsen, director of research of the Western Cartridge Company, East Alton, Illinois, chairman, and the Division of Colloid Chemistry, Professor R. A. Gortner, of the University of Minnesota, chairman, will join in a symposium on "The Physical and Colloid Chemistry of Cellulose and Cellulose Derivatives."

The Paint and Varnish Division, of which P. R. Croll, of Milwaukee, is chairman, will discuss plans for nation-wide research to improve the finish and durability of protective coatings.

Sanitation, water softening, sulfide wastes and other problems of the water supply of cities will be discussed before the Division of Water, Sewage and Sanitation Chemistry. The Division of Sugar Chemistry, the History of Chemistry Division and the Division of Rubber Chemistry will also meet.

Divisional officers of the society will convene on the morning of April 1, Erle M. Billings, of the Eastman Kodak Company, presiding. Officers of the eighty local sections will gather on the morning of April 2, with Dr. H. T. Herrick, of the Bureau of Chemistry and Soils, Washington, D. C., as chairman.

Trips of inspection to the industries and educational institutions of Indiana and many social events, including group dinners and luncheons, have been arranged. J. K. Lilly, R. E. Lyons and P. C. Reilly, of Indianapolis, have been named honorary chairmen of the general convention committee. Harry E. Jordan is general chairman.

The business reorganization of the society, reports of officers and committees, endowment plans and expansion of publications, involving the world-wide reporting of scientific developments for the use of American men of science, will be taken up by the council.

SCIENTIFIC NOTES AND NEWS

Dr. David Starr Jordan, chancellor emeritus of Stanford University, celebrated his eightieth birthday on January 19. Dr. Jordan was able to sit up for a short time to receive his most intimate friends. As a permanent expression of appreciation faculty, alumni and friends presented the "Jordan Room," his former office in the Zoology Building. This is to provide "a room beautiful in form and color, comfortable and convenient, in which his favorite subjects can be pursued for years to come." In Danville, at the foot of Mount Diablo, students planted a valley oak as a suitable expression of the strength manifested in Dr. Jordan's life. Dr. Barton W. Evermann, one of Dr. Jordan's first students at Indiana, was the principal speaker.

Dr. William H. Welch, professor of the history of medicine, and Dr. William H. Howell, professor of physiology and director of the School of Hygiene and Public Health of the Johns Hopkins University, will retire at the end of the present academic year. Dr. Welch was the first professor of pathology at the Johns Hopkins University School of Medicine, having been appointed in 1884. In 1916 he became the first director of the School of Hygiene and Public Health. In 1926 a chair of the history of medicine was created for him and in 1929 the new medical library was dedicated in his honor. Dr. Welch's eightieth birthday on April 8 of last year was marked by an international celebration. Dr. Howell, whose seventy-first birthday occurred on February 20, has been professor of physiology since 1893, succeeding Dr. Welch as director of the School of Hygiene and Pub-

lic Health in 1926. He was president of the International Physiological Congress held at Harvard University in 1929.

DR. ALBERT EINSTEIN will leave Pasadena late in February on his way home to Berlin. He expects to sail from New York on March 4. Just before sailing Professor Einstein will be the guest of honor at a dinner at the Hotel Astor to start a campaign for $1,000,000, the New York City quota in the nation-wide American-Palestine campaign for $2,500,000. More than 1,000 guests, who will pay $100 each, are expected to be present.

THE degree of doctor of science has been conferred by the University of Pittsburgh on Dr. Harlow Shapley, professor of astronomy and director of the Harvard College Observatory; Dr. Edward Ellery, professor of chemistry and dean of the faculty of Union College and secretary of Sigma Xi; Dr. George E. Coghill, of the Wistar Institute of Anatomy and Biology, and Dr. George W. Stewart, head of the department of physics at the University of Iowa.

RECIPIENTS of honors bestowed on the occasion of a dinner on February 18 of the American Institute of Mining and Metallurgical Engineers include Francis W. MacLennan, of Miami, Arizona, who receives the William Lawrence Saunders Medal for discovering a method to produce copper profitably from ores which had been considered virtually worthless; William H. Peirce, of Baltimore, the James Douglas Medal for numerous improvements in devices for smelting, refining and rolling copper; Edmund S. Davenport, of Kearny, New Jersey, the Robert W. Hunt award, for studies in cast iron, tungsten, thorium and transformation of austenite. Professor Waldemar Lindgren, geologist of the Massachusetts Institute of Technology, was made an honorary member of the institute.

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution, has been elected an honorary member of the Ornithological Society of Bavaria.

SIR WILLIAM BRAGG, Fullerian professor of chemistry in the Royal Institution, has been elected an honorary member of the British Institution of Electrical Engineers.

THE gold medal of epidemics has been conferred posthumously on the late Dr. Ernest Conseil, director of the Health Office of Tunis, and collaborator with Dr. Charles Nicolle in his work on typhus, cholera and plague.

THE Buchan Prize of the Royal Meteorological Society, awarded biennially for the most important original papers contributed to the society during the previous five years, was presented to Dr. C. E. P. Brooks at its meeting on January 21.

OFFICERS of the American Society of Naturalists were elected at the Christmas meetings as follows: Dr. S. J. Holmes, University of California, *president*; Dr. E. J. Kraus, University of Chicago, *vice-president*; Dr. Sewall Wright, University of Chicago, *treasurer*; Dr. Leon J. Cole, University of Wisconsin, *secretary*.

DR. MORRIS M. LEIGHTON, state geologist of Illinois, was elected president of the Association of American State Geologists and Dr. George C. Brannon, of Arkansas, secretary, at the recent annual meeting held in Washington, D. C. Plans were discussed for the sixteenth International Geological Congress, to be held in Washington in June of next year. Dr. W. C. Mendenhall, acting director of the Geological Survey, sketched the history of the congress. The major topic for investigation, he said, would be the petroleum resources of the world. A special committee has been appointed to deal with this topic. Its findings will be compiled and published in a monograph for distribution at the congress. A considerable sum is necessary in order to make the meeting a success. The Geological Survey is seeking a special grant from the federal government to aid in defraying expenses.

PROFESSOR GEORGE H. MEAD, head of the department of philosophy at the University of Chicago where he was appointed assistant professor in 1894 and has been professor since 1903, resigned on February 5, owing, it is said, to differences of opinion concerning an appointment made in the department by President Robert M. Hutchins. Dr. Mead will lecture at Columbia University next year. Professor Edwin A. Burtt and Associate Professor Arthur Murphy have also resigned, having accepted positions at Cornell University and Brown University, respectively.

MR. HAROLD L. MADISON has been appointed director of the Cleveland Museum of Natural History. For thirteen years Mr. Madison was director of the Park Museum, Providence, Rhode Island. In June, 1921, he became curator of education at the Cleveland Museum, and was appointed acting director upon the resignation of Paul M. Rea in January, 1928. From 1918 to 1922 Mr. Madison was secretary of the American Association of Museums.

DR. EDWARD R. WEIDLEIN, director of the Mellon Institute of Industrial Research at Pittsburgh, has announced the appointment of Dr. Leonard Harrison Cretcher to an assistant directorship in the institution. Dr. Cretcher, who since 1926 has been serving

as head of the department of research in pure chemistry, is a specialist in organic chemistry and will have supervisory charge of a group of industrial fellowships that are concerned with problems in organo-chemical technology. In addition to serving in this capacity, Dr. Cretcher will continue as head of the department of research in pure chemistry. In this work he will be aided by Dr. William L. Nelson, who has been made senior fellow in pure research. Beside Drs. Cretcher and Nelson, the departmental staff will include Dr. C. L. Butler and Dr. Alice G. Renfrew, who has gone to the Mellon Institute from the Sterling Chemistry Laboratory of Yale University.

DR. J. VOLNEY LEWIS, of New York City, has resigned as staff geologist for foreign operations of the Gulf Oil Corporation and has joined the staff of "A Century of Progress," where he will undertake to organize the work in geology, mining and metallurgy for the Chicago International Exposition in 1933 and to assemble the appropriate exhibits. The plans are being made and the work will be carried out with the cooperation of the National Research Council.

DR. C. E. K. MEES, director of research and development at the Eastman Kodak Company, who for a number of years has been an assistant editor of *Chemical Abstracts* in charge of the photographic section, has resigned, and Dr. E. P. Wightman, research chemist at the Eastman Kodak Company, has been appointed his successor.

DR. FLOYD W. VON OHLEN, formerly of the Ohio State University, has been appointed instructor in botany in the department of biology at Long Island University, Brooklyn, New York.

SEVEN dismissals from the faculty of Transylvania College at Lexington, Kentucky, are reported. They include Dr. C. A. Maney, for eleven years head of the department of mathematics. Dr. Maney is said to have received a letter stating that for purposes of economy his services would not be required next year. Transylvania College is supported by the "Disciples of Christ."

THE Committee on Scientific Research of the American Medical Association has granted to the New York Homeopathic Medical College and Flower Hospital for the work of Dr. Israel S. Kleiner, professor of chemistry, the sum of $500 to aid in work on crystalized enzymes. The Littauer Foundation has made possible the continuation of his work on studies in diabetes, by a second gift of $1,800. Mr. Lewis Emery has made a gift of $2,150 to Dr. E. Risley Eaton, associate professor of medicine, for studies in arthritis.

PROFESSOR T. H. GOODSPEED, on sabbatical leave from the department of botany of the University of California, and at present carrying on research in the biological institute of the Kaiser Wilhelm Gesellschaft under a fellowship of the Guggenheim Foundation, spoke at the third "Dahlemer Biologischer Abend" on January 12 on "Effects of High Frequency Radiation on Species of Nicotiana."

THE George Fisher Baker non-resident lecturer in chemistry at Cornell University for the present university term is Dr. Nevil V. Sidgwick, of Oxford University. Dr. Sidgwick will conduct a course of lectures on "Molecular Structure and the Periodic Classification" and will hold weekly colloquiums for the benefit of advanced students in chemistry. He is the eleventh holder of the non-resident lectureship founded by George Fisher Baker in 1925, which in accordance with the terms of the foundation is filled in succession by men eminent in chemistry or in some related branch of science.

YALE UNIVERSITY announces the appointment of Dr. Heinrich Wieland, professor of organic chemistry at the University of Munich, and one of the editors of the *Annalen der Chemie*, as Silliman lecturer for the current year. The subject of the lectures will be "Researches on Oxidation Reaction." They will be given at 4:15 P. M., in the lecture room of the Sterling Chemistry Laboratory on March 16, 18, 20, 23, 25 and 26. As provided for by the Silliman Foundation, these lectures in amplified form will be published by the Yale University Press as a volume of the Silliman series. A correspondent writes: "The eminence of Dr. Wieland as an organic chemist and biochemist and his important researches in the field which he has chosen for the subject of the forthcoming course ensure another notable addition to the Silliman series, which already includes many important contributions by distinguished scientists in various fields."

PROFESSOR R. H. FOWLER, of Trinity College, Cambridge, will give a series of twenty-four lectures at the University of Wisconsin on "Some Recent Developments in Theoretical Physics." The topics to be covered include electron emission, the theory of ferromagnetism, the internal absorption coefficient for gamma rays and Milne's theory of the internal constitution of the stars. The lectures will begin on April 1 and will continue through April and May. Visitors are invited to attend the lectures.

PROFESSOR CHARLES GALTON DARWIN, professor of natural philosophy in the University of Edinburgh, will lecture at the Lowell Institute, Boston, during March and April.

DR. FRITZ S. BODENHEIMER, author of the comprehensive "History of Entomology before Linné,"

known for his work on the relation of climate to epidemiology, has been appointed lecturer in entomology at the University of Minnesota for the spring term. His topic for the series will be "Insect Physiology, the Regulating Mechanism of Insect Epidemiology and Biocoenotics."

DR. KEIVIN BURNS, assistant director of the Allegheny Observatory, will give a lecture and laboratory course in "Precision Spectroscopy" at the coming summer session of the University of Michigan.

DR. GEORGE K. BURGESS, director of the Bureau of Standards, gave a lecture before the Maryland Academy of Science on February 18 as one of a series on the value of scientific research in industry arranged in cooperation with the Baltimore Association of Commerce. Under the leadership of Dr. Robert B. Owens, director of the academy, it is hoped to increase the membership to 500 and to collect $50,000 to assist in making the academy, of which Dr. William H. Howell, director of the School of Hygiene and Public Health of the Johns Hopkins University, is president, "a scientific instrument to render valuable assistance to the industries of Maryland."

DR. DAVID WHITE, principal geologist of the U. S. Geological Survey, will give a course of six lectures at Yale University under the auspices of the department of geological sciences during the last week of February and first week of March on "The Geology of Coals."

DR. JOSEPH C. ARTHUR, dean of American botanists, professor emeritus of botany at Purdue University, was the guest of the Pennsylvania State College on February 18 at which time he spoke on "Disentangling the Rusts" in the series of lectures sponsored this year by the School of Agriculture.

PROFESSOR JAMES F. NORRIS, of the department of chemistry at the Massachusetts Institute of Technology, will give three lectures at Bowdoin College during the coming semester under the auspices of the department of chemistry.

DR. S. O. MAST, of the Johns Hopkins University, recently gave an address on "Amoebae" before the faculty and graduate students in the department of biology of Western Reserve University.

PROFESSOR EDWARD W. BERRY, of the Johns Hopkins University, lectured recently at the University of Illinois. His subjects were: "The Evolution of Floras," "The Evolution of Faunas," "Principles of Paleontology," "Principles of Historical Geology" and "The Geological History of the Mississippi Embayment."

RECENT lectures given before the Royal Canadian Institute, Toronto, include a lecture on "The Geysers of Yellowstone Park," by Dr. Arthur L. Day, of the Geophysical Laboratory of the Carnegie Institution, and a lecture on "Wild Flowers" by Mrs. Mary Vaux Walcott, of the Board of Indian Commissioners.

LECTURES of the Royal College of Physicians will be given this year as follows: Surgeon Captain S. F. Dudley, R.N., will deliver the Milroy Lectures on February 26 and March 3 and 5 on "Some Lessons of the Distribution of Infectious Disease in the Royal Navy"; Dr. Macdonald Critchley, the Goulstonian Lectures on March 10, 12 and 17 on "The Neurology of Old Age," and Sir William Willcox the Lumleian Lectures on March 19, 24 and 26 on "Toxic Jaundice."

BY the will of the late Albert B. Kuppenheimer the University of Chicago receives an endowment fund of about $1,000,000 for medical research. The Michael Reese Hospital receives $500,000.

YALE UNIVERSITY will eventually receive a fund of $577,732, the income of which will be used to provide scholarships for students of American ancestry, under the terms of the will of Dr. William Whitney Hawkes, who was for many years one of Connecticut's leading physicians and surgeons. Dr. Hawkes was a graduate of the college and of the medical school.

THE new Charles Franklin Kettering Laboratory of Applied Physiology at the University of Cincinnati College of Medicine, Cincinnati, has been dedicated. It is designed primarily for research work in occupational diseases. Dr. Robert A. Kehoe is director. Mr. Kettering, of Dayton, and other industrial leaders, who contributed $130,000 for erection of the laboratory, have provided an annual fund of $40,000 for its operation.

ON account of the proximity of the forthcoming Pasadena meeting of the American Association for the Advancement of Science at the end of June, the executive committee of the Southwestern Division has voted to omit the regular meeting of the division which would ordinarily occur next April. The next meeting of the division will take place in Colorado, at a place as yet unselected, in the spring of 1932.

PREPARATIONS for the twelfth annual industrial conference at the Pennsylvania State College are being made by the School of Engineering. Dean R. L. Sackett announces that arrangements are being completed to have as speakers representatives of the foremost industries in Pennsylvania. The conference will be held for three days, May 13, 14 and 15, with the general aim of bringing the college into closer cooperation with industry, thus giving to industry a better perspective of the college work.

The fourth annual conference of workers who are engaged in the study of the root-rot disease (caused by *Phymatotrichum omnivorum*) was held at College Station, Texas, on January 19 and 20. This conference, which is part of the cooperative attack on the root-rot problem by the United States Department of Agriculture and the Texas Agricultural Experiment Station, affords a yearly opportunity for the prompt presentation of results secured during the previous year at the many laboratories and field stations at which work on the problem is under way. The 46 papers presented at the present conference included results from six laboratories and field and plat studies from eight stations. A total of 34 plant pathologists, soil chemists, agronomists, botanists and horticulturists took part in the discussions. Director A. B. Conner, of the Texas Experiment Station, and Dr. Oswald Schreiner, of the United States Department of Agriculture, presided at the various sessions. A report of the results presented at this conference will appear in *Phytopathology*.

On Wednesday afternoon, December 31, those interested in hydrobiology and aquiculture met for papers and discussion in the Herrick Room of the Medical Library Building of Western Reserve University. Dr. E. A. Birge, of the University of Wisconsin, acted as chairman. The secretary, Dr. P. R. Needham, University of Rochester, writes that this was the second special meeting of this group to be held in conjunction with the American Association for the Advancement of Science, the first having been held in Des Moines last year. The great amount of interest in these subjects was evidenced by the attendance which was well over one hundred persons. There were fourteen papers given, most of which were illustrated by lantern slides. Delivery of papers occupied most of the afternoon and discussion periods were all too brief. The subjects covered were as broad as the field of hydrobiology itself and were in most cases the results of research carried on by the speakers. Seven of the papers had to do with lakes and covered such phases as light transmission, gases in solution, thermal stratification, plankton, bottom faunas and fishery problems. Three of the papers were on ecology and life histories of fishes. The only paper having to do with salt-water was one given by Professor Thurlow Nelson, of Rutgers University, on oyster larvae and their reactions to currents and salinity of waters. Most of the papers had to do with pure hydrobiology. Little was said on the more practical aspects of aquiculture or the means by which our bodies of water are to be made into producing units. The meeting was very successful from all points of view.

The Council of the American Association for the Advancement of Science at the Cleveland meeting passed on January 1, 1931, the following resolution on the revision of the copyright laws of the United States:

Whereas, There is prospect of Congressional action at this session on the long discussed Vestal General Revision Copyright Bill (H. R. 12549), which includes among its many just and progressive provisions the qualifying of the United States for entrance into the International Copyright Union, and

Whereas, It is highly desirable that the United States outlaw piracy and thus in turn obtain for its authors and composers the automatic protection which is afforded by membership in this Union; it is hereby

Resolved, That the council of the American Association for the Advancement of Science hereby expresses its hearty approval of the Vestal Bill, and it is further

Resolved, *That the council recommends that, if without* defeating passage, the bill be amended to preserve to the individual, whether resident or incoming, his old privilege of importing for use all legitimate foreign books without intervention, and also to provide for adherence to the 1928 Convention of the Union instead of the 1908 convention, as provided in the present bill.

DISCUSSION

ORIGIN OF PALOUSE HILLS TOPOGRAPHY

That part of the loess-covered Columbia plateau which lies in the adjoining counties of Whitman, Washington, and Latah, Idaho, possesses a curious rolling mature topography which has puzzled geographers and physiographers because it appears to belie the topographic age of the surrounding and adjacent country.

This rolling topography has been locally called "the Palouse Hills" from the time of the early white settlers. It is an area of extremely dissected loess, with a relief of more than 150 feet bearing relatively few streams, and presents an aspect so unusual that it is gradually becoming known as a new type, the Palouse Hills topography.

Guesses at its origin over a period of forty years have attributed the unusual topographic forms to normal stream erosion, to aeolian deposition, even to barchan dunes of loess. Unfortunately, the field evidence fails to support any of these hypotheses satisfactorily.

The only topographic map of the area is the Pullman, Washington, quadrangle and its large contour interval and small scale fail to show the most characteristic features of the Palouse Hills topography. It was not until 1927 that Dr. Francis A. Thomson, president of the Montana School of Mines, but at that time dean of the School of Mines at Moscow, Idaho, crossed the region by aeroplane and noticed that nearly all of the intermittent streams tributary to the main drainage lines headed in cirque-like bottle-necked amphitheaters. The studies of the authors,

inspired by his observations, showed that about 90 per cent. of the minor valleys which drain into the regular stream channels are of the cirque-like amphitheater type. These valleys are streamless throughout the year and carry water only for a week or two in the spring when the snow melts and produces a temporary sheet run-off which is concentrated in the bottoms of the valley heads.

The cirque-like amphitheaters range from a few feet to several hundred yards in diameter. In the smaller ones the bowl or amphitheater is nearly circular in ground plan, but the larger and doubtless older ones have an oval plan, opening at the lower and smaller end to debouch into another amphitheater or into a normal stream valley. In all the smaller and younger types and in the majority of older and larger examples the debouchure is constricted into a small bottle neck. Variant forms have a constricted S-shaped neck or a non-constricted neck which is no wider than the cirque-like depression at the head.

The walls of the amphitheater are always notably steep and concave in profile. The depth is, of course, controlled by the thickness of the loess mantle which in some places approaches 200 feet. In no case is the depth greater than the width, and in the smaller ones it reaches only a few feet, while in the larger ones the depths are commonly 75 feet and more.

The amphitheaters are all enlarged and elongated by headward erosion and new ones are from time to time developed in the walls of the larger forms until a clover-leaf pattern becomes characteristic where two, three or more amphitheaters, each with a bottle neck, converge on the bottle-neck opening of the original amphitheater.

Studies during 1927–28–29 have permitted the detailed examination of more than sixty characteristic amphitheaters. The main drainage lines lead to the southwest and the cirque-like depressions are found on both sides of each valley and around the heads. Compass readings taken from the bottle necks to the heads were made on 65 amphitheaters and indicate a general tendency to orientation in two directions. About an equal number of amphitheaters headed to the west and opened to the east, southeast and northeast as compared to those which headed to the south and opened to the north, northeast and northwest. A few poorly developed amphitheaters headed to the north and opened to the south and southwest.

The relation of the depressions to the normal stream drainage is not the normal dendritic pattern. The amphitheaters may lie at right angles to the main valley or may join with obtuse angles opening up stream.

That the depressions were not caused by ordinary run-off and stream erosion is admitted by everyone who has given the area any study. That the crescentic depressions do not represent the lee side of barchan dunes is proven by the lack of orientation with the prevailing wind or with any consistent orientation in any one direction.

The best theory for their origin was suggested by Dr. J Harlen Bretz, professor of geology, University of Chicago. Upon his suggestion that nivation might have been a contributing cause the evidence was restudied and the writers are at this time reporting preliminary conclusions resulting from a three years study of the phenomena.

Nivation[1] appears to be the largest single contributing factor and appears to be the factor which determines the two directional orientation, the headward erosion and the cirque-like shape of the amphitheaters. Other factors, such as soil-slip, slump, mud flow and rill erosion, contribute in a minor way to the formation of these depressions.

The precipitation of the region occurs largely as snowfall and great drifts form on the valley sides and remain for several months of the year. The soft, easily eroded loess lends itself exceptionally well to erosion by nivation and to the formation of steep concave slopes on the uphill side of the drift.

The following lines of evidence indicate that nivation is the chief cause of the pseudo-cirques or amphitheaters:

1. The largest and best developed pseudo-cirques open in easterly or northerly directions. These are the sides of the valleys on which the snow drifts achieve the greatest depths and remain the longest because they are protected more from the direct rays of the winter sun. Very few hills or valley walls show concave slopes on the sunny side.

2. The steepest head slopes of the pseudo-cirques occur in those which face in northerly or easterly directions.

3. There is more mud on the north and east slopes. As long as six weeks after the south and west slopes are dry enough for cultivation, the north and east slopes are covered by mud which may be very slowly flowing across the floor.

4. In all cases the walls inside the pseudo-cirques are the steepest and most concave.

5. The drainage divides have been shifted from normal position because of greater headward erosion in some amphitheaters than in others. The divide which lies between two parallel streams flowing southwest bears amphitheaters on the southeast side which face east, southeast, and northeast, and amphitheaters

[1] François E. Matthes, U. S. Geol. Survey, Twenty-first Annual Report, Pt. II, pp. 179–185, 1900.

on the northwest side which face north and northwest. As these pseudo-cirques work headward the divide becomes staggered with cols, horns, and ridges analogous to the "grooved and fretted" divide in a range where mountain glaciation has occurred.

6. The mud flows are the largest on the slopes where the largest drifts occur. These in turn are in the largest valleys.

Nivation itself loosens up the loess, results in mud flows, develops concave depressions independent of drainage lines, and leaves no indication of scour or transportation.

The transfer of material from the upper edge of the snow drift, under the mass of the snow drift, by sheet erosion is very slow and would be imperceptible except for the mud flow which develops at the toe of the drift.

Annually after the drift has entirely disappeared the shady sides of the amphitheaters retain soil moisture much longer than the other sides and slump and soil slip result. The scar resulting from the slip exposes a still steeper surface in the loess to run-off and rill erosion.

During the early spring the walls of the amphitheaters are scarred by soil slips. These extend down the slope from the point of inflection to the bottom, forming black V-shaped gashes on the surface. The slips occasionally move the surface layer to a depth of one foot, but a few inches is the common depth. Gentle spring rains form rills, which in turn follow the soil slips and thus intensify and localize the erosion.

In conclusion it can be said that the predominant process of dissection of the loess-covered plateau is by the formation and enlargement of amphitheaters. All of the valleys and depressions regardless of age present the characteristic curves of maturity with the upper part convex and the lower part concave.

A full discussion of this type of erosion and topography is in preparation. It will be accompanied by large-scale topographic maps, cross-sections, aërial and landscape photographs and statistical data, all of which amply justify the above conclusion.

Virgil R. D. Kirkham
M. Melville Johnson
Donald Holm

Lansing, Michigan

A FOSSIL CYCAD IN NEW JERSEY

The clay deposits belonging to the Raritan formation of the Cretaceous near Woodbridge, New Jersey, which in the eighties of last century yielded so many fossil leaf impressions to Newberry, have recently furnished an unusual specimen. A member of the party of Rutgers University geologists who were removing a group of footprints of a dinosaur picked up the piece of lignite which forms the subject of this note, and submitted it to me for examination. The specimen represents the apical region of a trunk with a large number of scales standing out from this, the whole having a diameter of about 180 mm, while the diameter of the trunk proper is 85 mm. The tips of the scales have been worn away, so that the original diameter of the fossil was probably as much as 200 mm. Some detached scales measure about 50 mm long by 18 mm wide, and are 4 mm thick at the middle, which region forms a broad thickened ridge on each surface of the scale. These organs were apparently narrower and thicker in their distal region, contracting to a diamond-shaped area on the free end.

In spite of the weathered condition of the specimen it has been found possible to make out several imbedded fructifications which superficially resemble those of the cycadeoids described by Wieland and others. Although the axis of the specimen shows a poor state of preservation, certain of the scale-like organs look so favorable that they have been converted into serial sections by the celloidin method. A study of these has shown that they have precisely the same arrangement of their vascular strands as is figured by Carruthers for the leaf-bases of the English cycadeoids. Moreover, our specimen shows a well-developed covering of epidermal scales or ramenta of the same type as those figured by Carruthers and by Wieland. The minute structure of the vascular bundles of our specimen has been compared with Wieland's photographs and found to correspond. The evidence for the view that the scale-like lateral organs are leaf-bases appears convincing. A striking feature of the New Jersey specimen is the excessive development of periderm, which not only surrounds each leaf-base but penetrates it in various directions, resulting in an extensive fragmentation of the organ. An odd feature of certain leaf-bases is the presence of a fossilized fungus which appears to have been parasitic. The evidence at hand points with certainty to the conclusion that we have here a species of *Cycadeoidea*. The nearest locality from which the genus has been reported is Maryland. The discovery of a specimen in New Jersey raises some questions with respect to the sort of climate which prevailed in this region during the Cretaceous period. Taking into account the xerophytic characters exhibited by the conifers occurring in the Cretaceous beds of Staten Island, and described by Hollick and Jeffrey, we may venture the opinion that New Jersey was both warmer and drier during the Cretaceous

than it is at present, in fact the region may have presented more or less the aspect of a desert.

M. A. CHRYSLER

RUTGERS UNIVERSITY,
NEW BRUNSWICK, NEW JERSEY

PLURAL FRACTIONS

FROM time to time correspondents unburden their minds in these columns of sundry loads of worry about the low state of our written and spoken language. Constant Reader has learned to look for old friends among the words mentioned as horrible and convincing examples, and he would be surprised to find that the English courses in high school and college are not blamed for the deplorable condition. My own personal theory is distinctly different, but will not be aired now. The reason for writing is to call attention to a common mistake for which the decimal system must be blamed.

In reading common fractions such as $\frac{4}{100}$ or $\frac{893}{10000}$ gram, one naturally says "four one-hundredths (of a) gram," and similarly for the ten-thousandths. Yet in recent journals these fractions were given as "0.04 grams" and "0.0893 grams." It is not necessary to give references because the mistake is of wide occurrence, and is an argument for the practice of some journals never to use the names of units in the plural. It is easy to see why so many writers use and editors permit the wrong use of the plural. Think of the way decimals are commonly read. "Oh, point, oh, four gram—no, the last figure is four, so it must be grams."

The "oh," it may be remarked in passing, seems to indicate a great public necessity as the cause of the approaching obsolescence of "zero" in reading decimals. As for "naught" it seems to have died when we were young. Do school children still start the two table with "twice naught's naught"?

If the decimals we have given are bad, what can be said of 0.1 or 0.01 grams? Such expressions can be seen if the reader will look for them.

In tabulated data the column headings are often in the plural, though space is at a premium and all the figures in the column are less than unity. In a recent article "Potential, Volts" occurs seventeen times, though the maximum voltage is -0.825. In spite of the minus sign it would not be fair to say that the value is less than nothing, and is that much farther from being plural.

In the same number of the last journal negative powers of 10 play their frequent plural role. For instance, just because it is written 7×10^{-12}, the value 0.000 000 000 007 is ergs! One would like to say that this is a misprint, but the evidence does not in general encourage the charitable thought. On another page can be found "varied from 5–0. 3×10^{-4} g. calories." Seconds, grams and other units in varying negative powers of 10 are common occurrences.

Finally, in the ergs journal a writer says that so and so "occurs at every 2×10^8 collision." He would not think of writing or saying "at every two collision," but perhaps "at every second collision." Why was he led astray by an exponent?

C. E. WATERS

WASHINGTON, D. C.

WHY PATHOGENE RATHER THAN PATHOGEN?

IN printing this word, quite a good many authors in the states, including the U. S. Department of Agriculture and some universities, use the final "e"; many others do not and many abroad do not. As I recollect, the innovation started with the editorial board of *Phytopathology*. Doubtless the U. S. Department of Agriculture followed the usage of that journal, as did a few universities. I have had my doubts as to the need or even desirability of such usage and have always written the word "pathogen."

I was supported in my view by the opinions I received from several distinguished men of letters, among them Stuart P. Sherman, who said: "Why certainly not, no more use for the 'e' than in oxygen and hydrogen." I wonder if those insistent upon the final "e" use it in naming these two gases. I think the matter is also very well stated by my colleague Professor E. E. Schneider, of the faculty here, who says:

> To me pathogene seems simply absurd. Of course, English is so outrageously inconsistent in spelling that almost no rules can be laid down, but in a case like this, where we have such long-established analogous words as oxygen and hydrogen, I can't see any sense in using a different form. Anyhow, all these forms are from a root *gen* (as in Greek, γεννάω; Latin, gens, genus, generare) and *not* from some established nominal or adjectival form having a proper termination of its own, so why not let it go at that? It is true that *gene* has common use, but that is also an arbitrary modern formation, and so does not, to my understanding, constitute a valid precedent for other formations.
>
> My usual rule in the choice between two spellings is this: To choose the simpler one always when there is any authority for it at all, provided the simpler spelling is easily understood, does not conflict with any fairly well-established rule or practice and, finally, does not lead to any possible ambiguity.

Now a little matter of history. At about the time "pathogene" was being insisted upon there appeared

in *Phytopathology* quite a eulogy regarding some one who had hit upon the wonderfully useful term inoculum. I forget now who made this wonderful innovation. But I do know that for several years prior to that time I had been using the word inoculum and that many others also had done so.

F. L. STEVENS

UNIVERSITY OF ILLINOIS

SCIENTIFIC BOOKS

Living Africa. A Geologist's Wanderings through the Rift Valleys. By BAILEY WILLIS. New York: Whittlesey House, McGraw-Hill Book Company, Inc., 1930, pp. xv, 320, illustrated.

THE unique geologic feature of eastern Africa is its rifted plateaus with their rift valleys and their rift lakes. On no other continent are the ancient geologic formations so markedly split asunder, so torn apart, and so deeply cracked, and as a result it is one of the greatest regions of the earth for upwellings of molten rock from the heated interior. The rift valleys begin with the Dead Sea trough of Palestine, continue on through the deep Red Sea, and thence somewhat disconnectedly through eastern Africa to Lake Nyasa. In other words, the rift structures continue for 4,000 miles south of the Jordan.

The problem of the cause of this unique fault system has long fascinated geologists. Is it the consequence of tension, due to the deep subsidence of the Indian Ocean, which in late Mesozoic time began to pull down and break apart eastern Africa north to the Jordan? There is no agreement as to the answer, and it is therefore well that an American geologist who is fully conversant with the grand faulting of the Great Basin and California should take a good look at the rifting of eastern Africa and Palestine. This Willis has done under the fostering care of the Carnegie Institution of Washington, examining the rift valleys for a length in excess of 1,500 miles.

Central Africa is not only the land of high plateaus and long narrow lakes, but the place where the Congo and Nile rivers now have their origin; the country of active and recently extinct volcanoes, some with snowy tops; of much earthquake movement; of great mammalian game; of the deadly tsetse fly; and of nightly ice formation within the tropics. Amidst these interesting but frequently difficult conditions, Willis traveled more than 6,000 miles in six months, climbing volcanoes and walking twenty miles a day on safari, and all this in his seventy-second year!

"Living Africa" (living, because Africa is still growing geologically) is Willis' narrative of what he saw of the natural history, physical and organic, with accounts of the natives and the white people who helped him on his way, sprinkled with descriptions of the geological phenomena and what he thought about them from day to day. Later we are to get his technical report of the geologic structures and his final explanation of their causation. The present volume opens with "The Question" (pp. 1–15): How does the crust of the earth move?, continues with twenty-one chapters of narration (19–286), and closes with "The Answer" (287–310). It is a wonderfully interesting book, written in a clear, spirited, optimistic and humorous style, and why not, since the author was accompanied everywhere by his "Solomon"?

The Scottish geologist, J. W. Gregory, also visited the rift valleys of East Africa, first in 1892–1893 and again in 1919, and two years later published his book, "The Rift Valleys and Geology of East Africa." Willis agrees with Gregory that the Eastern or Great rift "is a crack, an effect of tension in the earth's crust," but adds, "We see the cause of tension from different points of view." The Great Rift valley of Africa is 650 miles long and from 20 to 30 miles wide; the superficial rocks are lavas and volcanoes piled upon a Precambrian crystalline basement. The Western rift is far more complex geologically than the eastern one and has a length of 850 miles. In Ruwenzori the old basement, here in the form of a wedge, has been squeezed upward through horizontal compression to 16,794 feet above sea-level, and other similarly shaped blocks have either risen or been depressed by the same forces. "The mountains said it, the rivers roared it, and the lakes acquiesced" (p. 96). It is the physiography of the plateaus, the curiously changed stream pattern, the nature of the crystalline basement on which rest the strings of volcanoes with their lava flows that guide Willis in his interpretation of the rifting and its causation.

"The recent uplift of the African plateaus and the development of the rift valleys constitute the group of facts that we have to throw against the background of the ancient history of Africa as a relatively modern expression of the forces that have created and shaped the continent since the beginning" (p. 291). These movements, in Willis' opinion, began in the late Mesozoic, and the first major upwarping, with differential movement of as much as 3,000 feet, may have taken place in the early Cenozoic. "The great western rift shows evidences of horizontal compression throughout its entire length" (p. 295). The Lake Victoria "disk" is 450 miles across, a high plateau with a saucer-like lake depression, and with margins that are upraised

mountain blocks and erupted molten masses. These marginal features are evidences of pressure exerted around the margin, pressure seemingly due to expansion of the disk.

The primary causation of all crustal movement, Willis thinks, is heat. The earth is "a heat engine, but I do not know how it works." Heat is the "tricky sprite that is forever playing with the established order of things," while the "great, primal, all-pervading force is the attraction of gravity" (p. 10). It appears, then, that the heat engine is at work when the deep-seated molten magmas rise into the thick crust or lithosphere and elevate large blocks into plateaus, while the subsequent crystallizing forces of the cooling intrusions plus gravity bring about horizontal pressure, rifting, and differential block movements.

Willis does not believe that there ever was a Gondwana continent, which foundered into oceanic depths in late Mesozoic time, making the Indian Ocean. He may be correct, but the reviewer prefers to continue his belief in theoretic Gondwana, and all the more so after reading "Radioactivity and Earth Movements" by Arthur Holmes (Trans. Geol. Soc. Glasgow, vol. 18, pt. 3, 1928–1929, pp. 559–606). Here also is to be found another hypothesis explaining rift valleys (see pp. 595–598).

The reviewer heartily recommends the reading of "Living Africa" to all geologists and graduate students in geology. The narrative illustrates how a master geologist works in the field, what he thinks about the phenomena seen, and how his conclusions change from time to time as observations increase. Students of structural geology are especially advised to study the first and last chapters in the book, so that they may learn more of the rise of certain geological theories, of the earth's primary internal forces, and of the "heat engine" of Willis. All in all, "Living Africa" is an interesting book, which stimulates thought along the line of multiple hypotheses.

Charles Schuchert

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF STAINING THE OOCYSTS OF COCCIDIA

All who have worked with the coccidia are familiar with the difficulties involved in studying the internal structure of the spores inside the mature oocysts. The refractive character of these bodies is often so pronounced that it is often next to impossible to observe for a certainty the number, size and shape of the sporozoites and the nature and size of the sporocystic residual body, if one is present. A study of the internal structures of the sporozite (nucleus, refractile bodies, granules) is often out of the question—a statement attested to by the frequency with which recent authors have omitted these structures from their figures. We have stumbled onto a technique which has proved extremely useful to us in some of our researches upon the coccidia.

The fecal material from the culture is strained through a double layer of cheesecloth. The filtrate is centrifuged in ordinary pointed centrifuge tubes, the supernatant liquid drawn off, more water added, and the mixture thoroughly shaken. This process is repeated three times in order to remove as much débris as possible. After the last centrifuging, concentrated salt solution is added to the sediment in the tubes, and the mixture is again shaken and centrifuged. The oocysts come to be present in the surface film and are transferred onto a glass slide by means of a platinum loop. The drop is covered with a No. 1 cover-glass.

A few drops of glacial acetic acid are placed on one end of the slide and barely in contact with one edge of the coverslip. The salt solution is withdrawn by absorbing it with a blotter at the other edge of the cover, and the acid follows the solution through the narrow space beneath the cover. Most of the oocysts are held in place by contact with the glass above and below when the proper care is taken in applying the cover. When it is certain that all the salt solution has been replaced by the acid, the slide is warmed gently over a light bulb for five or ten minutes. The acid is not permitted to evaporate, however.

At the end of this time the glacial acetic acid beneath the cover is replaced by a fresh Janus green solution made up in the proportion of one part of the dye to a thousand parts of distilled water. The dye solution is drawn beneath the cover by means of a blotter as explained above. The dye remains for ten minutes, and at the end of this time the oocysts are thoroughly washed by drawing distilled water beneath the cover-glass. The water is replaced by a concentrated solution of eosin in water, and this dye is left for five minutes.

Then follows a washing with distilled water as before. The entire process of staining may be followed under the low power of the microscope. If all the excess water at the margins of the cover-glass is removed by blotting, the edges may be sealed with amber vaseline or glycerine jelly. The stained oocysts should be studied under the oil immersion lens.

The oocyst jelly stains red, and sometimes the

sporocyst wall assumes a reddish tint. We can not agree between ourselves whether or not the sporozoites are stained a very light blue. At any rate the structures within the sporocyst are rendered visible. We suspect that the improved optical properties are the result of reducing the glare by staining the material about the sporocysts.

The foregoing procedure may be variously modified. The technique may be adapted to oocysts in a test tube instead of under a cover-glass. Also, we have found that if the fresh, non-sporulated cysts are used instead of those in the sporulated condition, development will occur beneath the cover-glass if heat is not applied while the preparation is flooded with acetic acid.

H. B. CROUCH
E. R. BECKER
IOWA STATE COLLEGE

THE LIGATION OF EARTHWORMS TO REMOVE THE ANTERIOR OR POSTERIOR END

DURING experiments conducted on the regeneration of blood vessels in earthworms, it was desired to remove the anterior thirteen somites. To effect this removal of tissue the following method was found to be superior to the usual method of cutting with a scalpel.

This method consists of tying the worm tightly enough to cause the end to slough off. In a six- to eight-inch piece of number 00 silk thread, a single knot is tied and drawn to a quarter-inch loop through which the worm is caused to crawl. The number of somites can be counted as the worm crawls through the loop and at the desired point the knot is drawn tight enough to constrict the worm to the smallest diameter without cutting the body wall. A little practice will determine how much pressure can be applied to the silk to obtain the desired result. This knot should be tied quickly and drawn against the finger with the ends of the silk on each side of the finger to prevent the worm from twisting into the thread. A second and third knot is then tied and the surplus silk clipped off.

The anterior end remains attached to the posterior for from two to four days; if it remains attached longer than this it is probable that the first knot was not tied tightly enough and a second tying is necessary.

This method is far more successful than that of cutting for several reasons. When the silk is tied around the worm a large quantity of mucus is secreted protecting the region. When the anterior end sloughs off the surface left exposed is very small, averaging about one millimeter in diameter. Around this end at the time of separation there is already a protecting fringe of proliferated epithelium. Extrusion of the digestive tract is very rare, allowing more rapid recovery. When worms are cut with the scalpel the contractions of the body wall often force the digestive tract out, and at best leaves a large surface exposed for bacterial infection, causing high mortality.

A point of great importance, in the work on blood vessels, is the retention of all the blood in the vessels. When the worms are severed by the scalpel much blood is lost. By tying, all the blood is kept in the vessels, leaving the worm in better condition

In summing up the advantages of this method it may be said that it is far superior to cutting, allowing the animal to readjust itself more gradually to the loss of tissue. While the shock of tying the worm so tightly may be as great as the shock of cutting, certainly the post-operative effects are not so great. Regeneration starts more quickly and proceeds more rapidly. Worms severed in this manner showed signs of feeding activities in about one to one and one half months.

L. S. ROWELL
UNIVERSITY OF VERMONT

SPECIAL ARTICLES

ON A RELEASE-PHENOMENON IN ELECTRICAL STIMULATION OF THE "MOTOR" CEREBRAL CORTEX

THE starting-point for this investigation was the question as to how the excitability of a motor point of the cerebral cortex and eventually the reactions obtained by its stimulation would be influenced, if changes occurred at all, when the surrounding parts of the cortex were put out of function. To avoid as far as possible shock-producing effects on the cortex, we decided to produce a functional block of the cortex round the motor point under investigation by local anesthesia with novocaine.

The general course of these experiments was as follows: general anesthesia of the animal by intraperitoneal injection of Dial (0.4–0.6 cc Dial Ciba per kg bodyweight), which leaves, as Fulton, Liddell and Rioch recently have shown, the cortex rather well excitable for electrical stimulation. After 1 to 2 hours, or even longer, when an even stage of narcosis is reached, the threshold of a point of the so-called motor cortex was determined for faradic bipolar or

unipolar stimulation during periods of from 5 or 10 seconds, at intervals of 1.5 to 2 minutes. After showing that several of these liminal stimulations yielded constant responses, 1 per cent. novocaine solution colored by toluidine blue was applied round the point, and the stimulation of the motor focus was continued at regular intervals of from 1.5 to 2 minutes. The area around the motor point, surrounded by the novocainized cortex, usually had a diameter of about 8 mm.

When the general condition of the animal remains constant, one finds in the cat, dog and monkey (*Macacus rhesus*) that after 8 to 15 minutes, usually at about 13 minutes, the excitability of the motor point is *augmented, i.e.,* the threshold for the point in question is diminished, or that when the strength of stimulus is kept unchanged throughout the whole experiment, the responses are distinctly stronger and even wider spread; a point which before the novocainization, at 13 cm coil-distance, gave rise to a slight flexion of the fingers of the contralateral hand, may now yield, at the same coil-distance, not only a much stronger flexion of the fingers, but also flexion of the wrist and often flexion of the elbow and retraction of the shoulder. In the cat and the dog we occasionally observed spread of the response to the hind limb of the same side, or, if the primary stimulation took place on the hind leg, a spread of response towards the front leg. Occasionally, also, a reversal together with augmentation of the response could be observed, *e.g.,* the primary liminal flexion changed after the novocainization into a much stronger extension of the same joint and of other joints of the same limb. Very often a marked clonic, partial epileptoid after-discharge entered into the picture. We have obtained in the monkey this augmentation of responses from the face, arm and leg areas of the cortex. This augmentation, which only sets in after a long latent period of from 8 to 15 minutes, subsides after 20 to 45 minutes. Renewed application of novocaine often gives rise once more to the appearance of the phenomenon.

Cortical facilitation is a well-known phenomenon since Exner discovered it in 1882; and especially so since through the investigations of Graham Brown and Sherrington it is known that cortical motor points do not yield fixed reactions, but are more or less "instable," because upon repeated stimulation of a motor point or after stimulation of another cortical antagonistic point, the response may be augmented or may change in pattern, *e.g.,* from extension into flexion (primary and secondary facilitation). These phenomena occur, at least so far as is now known, only when the two liminal stimuli succeed each other within a few seconds, intervals of one minute being sufficient to do away with any ordinary facilitation known at present. In introducing intervals of from 1.5 to 2 minutes we actually did not observe any facilitation, before the local anesthesia with novocaine.

The long latency of 8 to 15 minutes also points in the direction, that in this curious phenomenon of augmentation of response we have not to do with a primary phase of hyperexcitability of the local anesthesia. So far as we know, such a phase, if present at all, in local novocaine-anesthesia is much less marked than in local narcosis by cocaine and stovaine, and even here this primary phase of hyperexcitability through which the nerve goes (for which most of the investigations on changes in excitability during local anesthesia are carried out) occurs within the first minute or minutes after the application and soon passes away. Furthermore, novocainization of a motor point itself gives rise to a marked depression or even a temporary extinction of its excitability. We may safely assume, therefore, in our experiments, that this explanation does not account for the augmentation of response.

The explanation of our phenomenon is difficult to give in the present state of our knowledge of cortical functions. Perhaps the most probable hypothesis is to look upon it as a phenomenon of "release" of function in the sense of Hughlings Jackson and Head, the excitability of a small area of the cortex cerebri becoming (temporarily) augmented when it is "released" from the influence of the surrounding cortical areas.

We have not succeeded in obtaining this phenomenon after circumcision of a cortical point; the circumcision gives rise, as might be expected, to a long lasting depression or loss of excitability of the motor point. Apparently we succeeded in establishing our phenomenon with novocaine because this drug blocks functionally, but without producing cortical shock.

J. G. Dusser de Barenne
Clyde Marshall
Department of Physiology,
Yale University

THE ETIOLOGY OF SWINE INFLUENZA

Swine influenza ("hog flu") was first recognized as a clinical entity in 1918 and since then has reappeared in epizootic form each autumn and winter in the swine raising states of the middle west. It bears a striking resemblance to influenza in man. Experimentally, the disease can be readily transmitted by contact and also by the introduction of tracheal exudate from infected animals into the nasal passages of normal swine. Eight strains of the disease have been established among our experimental swine during the three years it has been under investigation in this laboratory.

In these experimental infections as well as in diseased animals studied in the field an organism, first isolated by the late Dr. Paul A. Lewis, with whom this investigation was started, has been found constantly

present. This organism is very similar if not identical to non-indol-producing strains of Pfeiffer's bacillus. Oftentimes the organism has been obtained in pure culture from the involved lung and bronchial exudate. It has not been found in the respiratory tract of normal swine. Freshly isolated cultures of the organism, when administered intranasally, may produce a disease which might be confused with the natural infection in swine but which, unlike the natural disease, is not contagious. Cultures on artificial media for two months or longer are non-pathogenic.

Suspensions of tracheal exudate and lung from infected animals passed through Berkefeld N filters, when introduced into the nasal passages of normal swine, cause a variable disease complex, apparently dependent upon the strain of infectious material under study. One strain, obtained in 1928, produced a clinical picture and lesions which closely simulated those following the intranasal injection of unfiltered infectious material. With other strains the disease produced by the filtrate has been very mild and transient and sometimes difficult of certain recognition. The contrast between the mild disease caused by the filtrate and the typical disease induced by unfiltered infectious material has been particularly striking with two strains of the disease obtained in 1930. In all instances bacteriological examination of the lung and tracheal exudate of filtrate infected swine has failed to reveal the influenza-like organism and sometimes these sites have been found bacteriologically sterile. The mild disease induced by the filtrate is contagious.

If a small amount of a culture of the influenza-like bacillus, carried on artificial media for over two years and long since non-pathogenic for swine, is added to a Berkefeld N filtrate and this mixture injected intranasally into normal swine, a typical swine influenza results and this disease is transmissible by contact to other swine. In such experiments control animals inoculated with culture alone remain perfectly normal, animals receiving filtrate alone develop a mild, transient, scarcely recognizable disease, while animals receiving a mixture of the two develop typical swine influenza.

The experimental data obtained in the investigation and briefly outlined in this note indicate that the primary inciting agent in swine influenza is filterable. However, since the influenza-like bacillus is always found in field and experimental cases and is capable experimentally of converting the mild disease caused by the filtrate into clinically and pathologically typical swine influenza, it seems probable that both the filterable agent and the bacillus are etiologically essential to the production of the disease and that, in this rôle, they act synergistically.

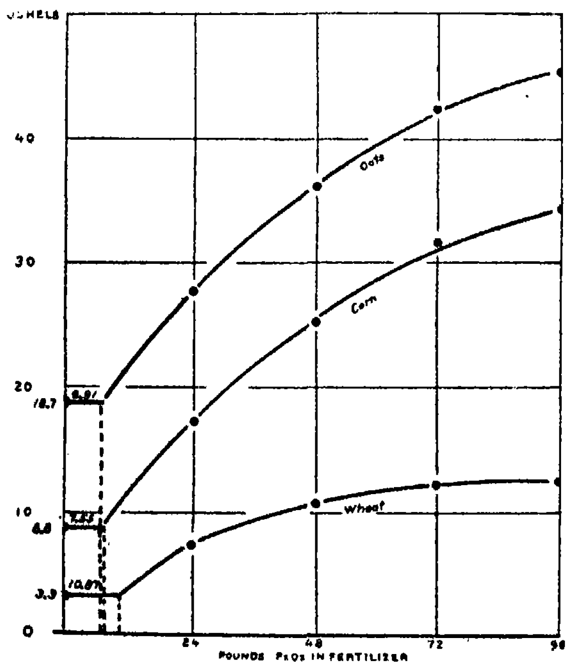
It is conceivable that these results may be suggestive in the study of influenza and certain other respiratory infections in man and animals.

RICHARD E. SHOPE
THE DEPARTMENT OF ANIMAL PATHOLOGY,
THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH,
PRINCETON, NEW JERSEY

MEASURING ABSORBED PHOSPHATES AND NITROGEN

WHEN phosphate or nitrate fertilizers are applied in certain cases small amounts of the plant food element appear to be absorbed by the soil and held in a condition unavailable to the growing crop. The usual increase in yield with increasing applications appears not to begin until the quantity applied exceeds the amount that can thus be absorbed. Whether potash is similarly absorbed is not yet known.

The purpose of this communication is to point out what seems to be a method of measuring the amount of a plant food element absorbed in the manner above described. The accompanying drawing shows the relation between amount of phosphoric acid applied and corresponding yields of oats, corn and wheat at the Snowshoe Branch Station of the Pennsylvania Experiment Station, as reported in Pennsylvania Bulletin No. 166.



The dots along the curves show actual yields. The curves are calculated from the yields for 24, 48, 72 and 96 pounds of P_2O_5 for each crop by means of the equation

$$Y = M - AR^x \qquad (1)$$

in which Y is the yield when x units (of 24 pounds each) of P_2O_5 are applied per acre, M is the maximum toward which the yield increases as x increases indefinitely, A is the difference between M and the yield for $x=0$, and R is the ratio of the decreasing geometric series of which the terms are the increments of Y corresponding to successive unit increases in x.

From applications of 24 to 96 pounds of P_2O_5, the agreement between actual and expected yields is excellent. But in each case the yield for $x=0$ lies considerably above the curve. The facts are explained if we assume that, of the phosphates applied, 6.91 pounds per acre are absorbed by the soil and held in a condition unavailable to oats, the corresponding figure for corn being 7.55 pounds and for wheat 10.87 pounds.

In previous work I have found that corn can obtain considerably more phosphate from a given soil than can wheat.

If the above assumptions are correct, oats should have yielded the same for any application of P_2O_5 between 0 and 6.91 pounds; corn for applications between 0 and 7.55 pounds, and wheat between 0 and 10.87 pounds. The validity of this assumption could easily be tested by a series of applications such as 0, 2, 4, 6, 8 and 10 pounds in addition to the application actually used in these experiments. A number of replications would be necessary to insure accuracy in the yields obtained.

The method of determining the values 6.91, 7.55 and 10.87 is simple. It is merely to find the point on the respective curves at which the value of Y in equation (1) above is the same as the observed yield at $x=0$. The values of the constants in equation (1) were determined by the method of least squares from the yields at $x=1$, 2, 3, and 4 units of 24 pounds P_2O_5 each.

Niklas and Miller, in an article[1] dealing with the form of the yield curve, assemble nine series of experiments with nitrogenous fertilizers, in all of which the phenomenon of nitrogen absorption is plainly evident. I have taken the trouble to recalculate the constants in the yield equation for each of these nine series, first with the yield at $x=0$ included, second, with this yield omitted. In each case the curve calculated without the yield at $x=0$ fits the observed yields better than that calculated with Y_0 included. This indicates that some nitrogen is actually absorbed in each series of experiments. Evidence of nitrogen absorption also appears in some field experiments in this country, particularly on delta soils in Mississippi.

In view of this situation it is obvious that in accurate experimental work with fertilizers the check plots should not be left unfertilized; they should receive an application of fertilizer at least as large as the quantity the soil is capable of absorbing and holding in a condition unavailable to the growing crop.

W. J. SPILLMAN

BUREAU OF AGRICULTURAL ECONOMICS,
U. S. DEPARTMENT OF AGRICULTURE

1 H. Niklas and M. Miller, "Beiträge zur Mathematischen Formulierung des Ertraggesetzes," *Zeitsch. f. Pfl.-ernahr., Düng. u. Bodenkunde*, Teil A, 8 Band, Heft 5., S. 289–297.

BOOKS RECEIVED

Abstracts of Theses: Ogden Graduate School of Science. Volume VII. Pp. xi + 484. University of Chicago Press. $3.00.

ADAIR, FRANK E., Editor. *Cancer: Comprising International Contributions to the Study of Cancer in Honor of James Ewing.* Pp. xix + 484. 168 illustrations. Lippincott.

American and Canadian Committees on Modern Languages. A Summary of Reports on the Modern Foreign Languages. Pp. vii + 261. Macmillan.

D'ALVIELLA, GOBLET. *Histoire des Bois et Forêts de Belgique.* Volume IV. Pp. 448. Illustrated. Paul Lechevalier, Paris.

DODGE, RAYMOND. *Conditions and Consequences of Human Variability.* Pp. x + 162. Yale University Press. $2.50.

EATON, RALPH M. *General Logic.* Pp. xii + 630. Scribner's. $3.00.

FRAME, W. S. *Stream Gaging in Arkansas from 1857 to 1928.* Pp. viii + 141. Illustrated. Arkansas Geological Survey.

GARTH, THOMAS R. *Race Psychology.* Pp. xiv + 260. Whittlesey House, McGraw-Hill. $2.50.

GERMAIN, LOUIS. *Faune de France.* Volume XXI: Mollusques Terrestres et Fluviatiles. Pp. 477. 467 figures. 13 plates. Paul Lechevalier, Paris. 150 fr.

GILLESPIE, JOHN W. *New Plants from Fiji.* Pp. 99. 57 figures. Bernice P. Bishop Museum, Honolulu.

HIROA, TE RANGI (P. H. Buck). *Samoan Material Culture.* Pp. xi + 724. 338 figures. 56 plates. Bernice P. Bishop Museum, Honolulu.

JUDD, HENRY P. *Hawaiian Proverbs and Riddles.* Pp. 91. Bernice P. Bishop Museum, Honolulu.

LODGE, SIR OLIVER. *Beyond Physics.* Pp. 184. Greenberg. $2.00.

LOVE, CLYDE E. *Elements of Analytic Geometry.* Pp. xi + 147. 85 figures. Macmillan. $1.60.

MCLESTER, AMELIA. *The Development of Character Traits in Young Children.* Pp. xvi + 126. Scribner's. $1.25.

MEYER, WILLY. *Cancer.* Pp. xxxiii + 427. 16 plates. Hoeber. $7.50.

WARMING, EUGENE, and P. GRAEBNER. *Lehrbuch Der ökologischen Pflanzengeographie.* Pp. 480. 232 figures. Verlag von Gebrüder Borntraeger, Berlin. 24 M.

YONGE, C. M. *Scientific Reports: Great Barrier Reef Expedition, 1928–29.* Volume 1: No. 1. Origin, Organization and Scope of the Expedition. Pp. 11. 4 plates. 2 shillings.
No. 2. Studies on the Physiology of Corals: Feeding Mechanisms and Food. Pp. 57. Illustrated. 5 shillings.
No. 3. Studies on the Physiology of Corals: Digestive Enzymes. Pp. 81. 2 shillings. British Museum (Natural History), London.

SCIENCE

Vol. 73 FRIDAY, FEBRUARY 27, 1931 No. 1887

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SCIENCE AND THE SUPERNATURAL[1]

By Dr. A. J. CARLSON

UNIVERSITY OF CHICAGO

I INTEND to make this discourse more modest than the title, and I trust you will find it so. Science is one, at least in its essential element, the method of reaching approximate truths. But scientists are many. On the topic before us it is preposterous for any man to speak for science as a whole and, by inference, for all scientists. We have scientists who still pray to the gods, scientists who laugh at the gods, and some who neither pray nor laugh, because they think they understand. I am sure all you expect of me this evening, and certainly all I intend to do, is to discuss the supernatural in the light that years of service in the science of physiology have given me. The topic of this discussion is not of my own selection. The views are my own. But they are neither unique nor original, except in the sense of being derived from cogitation on the common life, cogitations disciplined by years of research. I am not foolish enough to pretend that I am about to present to you anything that is both new and true. There are able tomes on the nature of science; and literature, *ad infinitum,* on the supernatural, especially in religions. There are able works on the conflicts between science and the supernatural. There are attempts at reconciliation of the supernatural with science. We have, in print, confessions of faith in traditional religions by otherwise competent scientists. We have, also in print, rejections of the supernatural by preachers and teachers of religion. I assume you are familiar with some, if not all, of this literature. Everything I am going to say has already been said, perhaps better, by other people. Nevertheless, here is the confession of a physiologist of lack of faith in the supernatural, and his reasons.

[1] William Vaughan Moody Lecture, University of Chicago.

Science

It is scarcely necessary, before this audience, to go into detail as to what we understand by science, although the term is frequently used loosely and with very different connotations. Probably the most common meaning of science is a body of established, verifiable and organized data secured by controlled observation, experience or experiment. Such data frequently lead to an approximate understanding of the causal relations between events, and these relations give us the so-called laws of science. To my way of thinking, the element in science of even greater importance than the verifying of facts, the approximation laws, the prediction of processes is the method by means of which these data and laws are obtained and the attitude of the people whose labor has secured them. In other words, the most important element in science appears to be the scientific method. What is the method of science? In essence it is this—the rejection *in toto* of all non-observational and non-experimental authority in the field of experience. No matter how high in state, church, society or science the individual may be who makes pronouncement on any subject, the scientist always asks for the evidence. When no evidence is produced other than personal dicta, past or present, "revelations" in dreams, or the "voice of God," the scientist can pay no attention whatsoever, except to ask: How do they get that way? If evidence is produced, he proceeds to examine the evidence. Does the evidence justify the conclusions or statements made? There is nothing recondite or abstruse in the method of science. To be sure, in many fields of scientific research methods of approach, methods of experimentation and data leading to certain or probable conclusions are becoming increasingly so recondite and specific that laymen in general and, in fact, scientists in other fields, are unable to follow, but the principle of the method is simple enough, and that this method of approach will give us the closest approximation to understanding and truth that we are able to reach to-day I think will be agreed to by all informed people.

The principle of the scientific method, in fact, is only a refinement, by analysis and controls, of the universal process of learning by experience. This is usually called common sense. The scientific addition to common sense is merely a more penetrating analysis of the complex factors involved, even in seemingly simple events, and the necessity of numerous repetitions and controls before conclusions are established. Where laymen, as a rule, do not understand or apply the scientific method is in the matter of controls. Thousands of honest errors have been committed and ludicrous conclusions promulgated by failure to understand the necessity of controls. Illustrative instances of this may be cited from the field where I have most experience, namely, physiology and disease. Fortunately, man recovers, as a rule, spontaneously from many diseases, such as colds, pneumonia, typhoid fever, headaches, diarrhea, etc. To be sure, some of these diseases may also lead to death, but if the person having these ailments does not die in the process of the malady, there is more or less complete recovery. Now, if the person not aware of this has the notion handed to him by his father, his priest or his mythology that holy water, holy oil, an amulet, a prayer, the killing of a goat or the laying on of hands will cure these diseases, experience will teach him that after applying any one or all of these measures to the sick persons many of them do get well. Indeed, applying all these to the sick might be a kind of control because a thinking person might be led to wonder which of these measures was the most potent in reestablishing health, and such questioning might lead him to try whether the person might recover without any of them. But usually this is not done. Those who believe that ill health can be cured by prayer will pray. Those who believe that an amulet is a cure will apply the amulet, and those who have faith in holy oil or laying on of hands will try these methods, and most of the people get well. A true statement of the facts is that sick persons so treated do get well after the treatment. The common error made is that the person recovers because of the treatment. The experience is correct. The conclusion is wrong. There is no control. The obvious control, of course, is a sufficient number of people of the same age with the same malady and none of the above measures applied, and the duration of their illness and percentage of recovery contrasted with the treated group. Until consciousness of the necessity of controls in all endeavors to ascertain new truths or in evaluating current theories, dogmas or practices, until this consciousness has become a compelling factor in society, man remains essentially unscientific no matter how much detailed scientific facts he may remember and how much scientific patter he may have absorbed. He is like the rooster who crows every morning before daybreak, notices that a little later the sun rises, and then concludes that it is his crowing which brings the sun above the horizon.

It seems that the supernatural in the sense of religions or a religious attitude toward nature and life is nearly universal among men at some stage of development. Science in the sense of elements of the scientific method, the learning by experience, is even more universal. It antedates man. The amoeba appears to work in part by the principle of trial and error; so do some of the higher animals, including the ape. This type of reaction or behavior in the

simpler forms of animal life does not necessarily connote conscious associative memories, but there is no good reason for denying the latter factor in the higher animals. The trial and error method is direct experience. Experience is experimentation in embryo. The very fact that every known race or tribe of humans has changed (some say progressed or improved) in the practical arts of living, in mores, in social organization and in religion is evidence of some learning by experience, despite all the retarding force of tradition and myths, and despite the absence of conscious control and analysis. Learning by experience, however, can not be dignified as science until a critical analysis of the factors and rigid controls of experience are introduced.

The *attitude* of the scientist is also an important factor in application of scientific method and therefore in the science itself, or at least in the growth of science.

This attitude is, of course, partly characterized by challenge of authority, be it man or God. It is further characterized by a serious attempt on the part of the scientist to control his own emotions and his own wishes in the matter. The scientist is, after all, an ordinary human being and the control of his desires, emotions or wishes in a problem is seldom, if ever, one hundred per cent. The scientist tries to rid himself of all faiths and beliefs. He either knows or he does not know. If he knows there is no room for faith or belief. If he does not know he has no right to faith or belief. He may have grounds for hypotheses, but the moment he begins to have faith in his hypotheses the hypotheses tend to become myths. One of my teachers in zoology used to say to us: "Friends, it is necessary, at present, to entertain theories in zoology, but we must be on our guard against being entertained by these theories." These elements of the scientific attitude I have indicated are scientific ideals which few, if any, scientists are able to attain all the time, particularly when they are dealing with matters of tradition or matters to which they are emotionally conditioned in early youth.

The term science is sometimes limited to the fields of mathematics, astronomy, chemistry, physics, geology, biology, and their practical applications. This may be due partly to the fact that in these fields we have to-day the greatest body of verifiable data and so-called laws of science. However, one of the elements in the scientific attitude is the application of the scientific method to the entire universe, including all human experience and all human relations. The man of science seeks for evidence in the case of all traditional beliefs and practices, and he must abstain from positive views when evidence is lacking in these fields just as he does when evidence is lacking in his own particular field of endeavor. Of course, it is much more difficult to apply the method of science to such fields as religion, social customs, political and economic institutions. Scientific controls are not readily devised or secured, but the application of the method of science in these fields has justified itself by results. It has afforded us a better understanding of the origin of our social heritage, even if it has not to date yielded any considerable body of verified data or laws similar to that of physics, chemistry, geology or biology. To the oft-repeated question—Are psychology, sociology, economics, etc., real sciences?—I would answer: They are, to the extent that the rigid application of the scientific method and scientific attitude is pursued by the people who cultivate these fields. The biologist is confronted in his own field by some of the difficulties that other scientists experience when they enter the fields of sociology, political science, psychology or religion. The past seems to be behind us despite the idea recently advanced that time may actually run backwards. Time may run backwards or in circles in the mind of the philosopher, but it does not seem to run backwards in biology. At any rate the history of the early ancestors of living plants and animals, and possibly the very origin of life itself, is only dimly written in the strata of the earth of bygone geological epochs. We may discover and describe a link here and there, but many of the links are as yet missing. We can not experiment with the past, we can not establish controls. Not only that, but many of the processes in the life of the individual man, animal or plant of to-day appear to be as complex, as difficult to analyze and separate and therefore control as the complex forces in society.

So much for science. If we have rightly understood and correctly outlined the method, attitude and scope of science, we might stop right here, and let you draw your own conclusions as to the supernatural, the "holy," the "divine." It might be better thus, for those of you who have already done so will be bored by the rest of this discussion; and others might take the conclusions on my mere say so, or reject them because contrary to their faith. In either case further discussion is largely futile.

THE SUPERNATURAL AS A WAY TO KNOWLEDGE

By supernatural we understand information, theories, beliefs and practices claiming origins other than verifiable experience and thinking, or events contrary to known processes in nature, such as the production of wine from water alone; the resurrection from the dead of persons in advanced stages of decomposition; accounts of creation of the world and of man by people who were not present at these events, and not in a position to infer from cosmic data; specific

codes of behavior enunciated directly to some man by some anthropomorphic god; arrest of the course of the sun through space so that the Jewish army could see to kill a few more natives; casting devils out of men, and sending demons into hogs; human pregnancies solely through non-material, that is, divine agencies; perpetual recurrence of a species of "immaculate conception" in that a divinity sends embryonic "souls" into every human fetus either at the moment of union of sperm and ova, or later in intra-uterine life, etc., *ad infinitum, ad absurdum, ad nauseam*. This supernatural has been presented to man with varying degrees of clarity in a great variety of books and sermons by prophets, priests, and other holy men, in addition to the information in so-called sacred books, such as the Bible, the Koran, the Vedas and the book of Mormons. We all know that there are great variations among modern adherents of the sundry religions both in the amount that they individually accept and in interpretations put on what they do accept of this supernatural. But the supernatural in this sense is found at present in the theories, beliefs and practices of most, if not all, religious groups. We find a sprinkling of it here and there in social habits, customs and ethics. At one time it was prominent in political institutions and theory, but in most parts of the world "rule by divine rights" has been abolished, at least in theory. The gradual elimination of the supernatural and the divine in governments can not be primarily credited to science or scientists. It was forced by the travails of the common life. The supernatural sanction in social customs, habits or ethics frequently touches matters of relatively little importance, such as the interdiction of eating pork for the Jew, and the eating of meats on Friday for the Catholic, the ritual of baptism in the Christian religion, the circumcision in the Jewish religion, shaving or not shaving the face or the head, etc. The dogma that each individual marriage, when solemnized by a priest, is a "sacrament" made in Heaven by Almighty God and holds "till death do them part" has a more practical significance.

I am no authority in this field, but according to the best information now available it would appear that early mores had little or no connection with the supernatural. The grafting of the supernatural on ethics appears to come relatively late in human history. At any rate, so far as the essential mores of practical living is concerned, similar principles have been developed in various social groups independent of, parallel with, or under the influences of a variety of religious beliefs. These, therefore, have the sanctions of social necessity, convenience, or safety quite apart from the supernatural.

The supernatural is particularly abundant in the field of religions. I shall not attempt the impossible, *viz.*, a definition of religion. We have, however, people who entertain religious theories and follow religious rituals. When I speak of the Jewish, the Christian or the Mohammedan religions I refer to the theories, practices and attitudes peculiar to the people in these religious groups. I think we may get somewhere in the discussion if we treat religion in this way rather than by abstract definition. Most religions have in common the view and belief that some time somewhere God or gods, supernatural beings, communicated to man information on the origin and nature of the universe, on the origin and nature of man, on the nature and control of the forces of nature about us, on the nature of evil, etc. In most cases these so-called revelations occurred so long ago that the person or persons receiving them are buried in obscurity and myths. We can not analyze the alleged facts and circumstances. Fortunately, we have in this country two recent divine revelations of this type, namely, Mormonism on the basis of the Book of Mormons, and Christian Science on the basis of the divine teaching of Mary Baker Eddy. These are so recent that the personalities and the circumstances involved are not yet entirely obscured by myths and lore.

What has science to say to all this? The most serious aspect of the supernatural is, not the revelations, *per se*, the miracles, the myths and the guesses, but the injunction that all this must be taken on faith, that inquiry and doubt is tabu—that is, sin. A good deal of "revealed" information about the nature of the world and the nature of man has proved entirely erroneous. So far as the nature of the world and of man is concerned the revelations appear to be nothing but what could have been projected as guesses by any human contemporary of the revelations, on the basis of the knowledge and the ignorance of those times. The "revelations" have been of no aid in the advance of real knowledge of cosmognony, physiology, physics, chemistry or disease. On the contrary, they have, through human stupidity and obscenity, frequently aided in retardation. The revelations to Joseph Smith (the Book of the Mormons), the repeated revelations by Jehovah to Brigham Young, and the rise of Christian Science are recent. The character, education, intelligence and environment of the people concerned are fairly well known. In the light of all the known facts in these instances, is there any intelligent man or woman to-day, not steeped in childhood in the lore of Mormonism or Christian Science, who can have any respect for such revelations as a source of knowledge? When the Mormon leaders received a tip from God that po-

lygamy was ordered by him for his chosen people on earth (by the way, a revelation that is easy to take by the average human male), the United States Government did not hesitate to challenge God, or Brigham Young's sanity and veracity. The Federal Government was powerful and adamant and God yielded through a second revelation to the effect that he had changed his mind and polygamy was no longer according to the plan of God! In some cases the "revelations" are reported as coming through dreams; in other cases through brush fires; by direct writing of the finger of God on stones, or indirectly through oracles, popes, the flight of birds and the liver of slaughtered bulls.

The physiologist can not accept revelations from dreams any more than he can detect wisdom in hallucinations. The brush fire may reveal something of the nature of the world, but it can tell us nothing of the origin of man or the ways of the good life. The supernatural as a way to knowledge is in direct conflict with science.

That many intelligent people of to-day both inside and outside the religious groups reject much of the anthropomorphism of the gods and the more palpably absurd phases of the supernatural as a way to understanding is no news to you. They usually retain a distillate of the supernatural in form of beliefs in a "moral purpose" in the universe. And having injected human ethics into an obviously a-moral universe,[2] they endow man with personal immortality. This refined supernaturalism is still essentially anthropomorphic and homocentric. Even this form of the supernatural has no sanction in science or analyzed human needs, as I understand them.

The Content of the Supernatural Revelations

So far we have considered the supernatural mainly from the aspect of the way of learning, the way of extending knowledge, the way of greater approximation to truth. A word or two on the content of the supernatural seems in place here. Most of the weird stories of creation of the universe, animals, man, of divine or demoniacal control of natural forces, of disease, etc., that have come to us *via* the supernatural route run contrary to facts now known, or rendered untenable, as possibilities, by known facts. Between the stories in the book of Genesis, as an article of faith, and the planetesimal hypothesis of Chamberlin and Moulton (probably the greatest intellectual achievement so far in the University of Chicago) as a working theory, science *must* choose the latter. Divine benevolence and wrath, devils and demons are not factors in health and disease, according to the data of modern medicine. Science and miracles are incompatible. Much happens in nature and in man for which science has yet no complete analysis of the causal chain. We recognize the unknown but not the unknowable. When we know that we don't know, that is itself an achievement, for then the field is cleared of the confusing and obstructing rubbish of tradition, and we are free to use all our ingenuity and imagination in contriving methods to find out. Miracles of sufficiently recent occurrence so that fair information is available of the alleged facts and circumstances are resolved into misrepresentation or misinterpretation of the facts. In regard to the recurring miracle of changing bread and wine into human flesh and blood by Christian rituals, biological and biochemical tests of the bread and wine after being subjected to such rituals reveal nothing but the original bread and wine. To persons fairly familiar with biology and physiology the theory of animal and human evolution and genetic relations is a closer approximation to what happened in the past than any guess or story in "sacred books" or mythology. I have a fair acquaintance with most of them.

The theory of dual nature of man (body and "soul") and its equal: The theory of *personal immortality* appears to be partly of mythological and supernatural origin, partly philosophical. The alleged objective evidence of these views is entirely mythological and supernatural, unless we are to dignify as evidence the ancient and modern communications with the dead by clairvoyance, "psychic mediums" and "ectoplasm." When examined, the "ectoplasm" appears to go the way of all errors and frauds. I know these attempts, and I am still skeptical.

Has science anything to say on the theory of personal immortality? The idea of persistence of the individual after physical death came down to us from the ancients in most if not all races. What credibility are we going to give to the idea solely because of its venerable age? So far as I can see, we can give no greater credibility to the ancients, views on immortality than to their views on other things about which they knew nothing. Conscious phenomena and intelligence in man, that is, personality, appear to be just as much an evolution of the material world as is the rest of the body processes. We seem to be forced to this conclusion from the evidence of the intimate dependence of all phases of consciousness, memory, and personality on the quantity and quality of the nervous system, and these, in turn, depend on all the rest of the body mechanisms.

[2] The concept of moral and immoral behavior has developed in connection with normal human adults or any hypothetical personality, to whom we ascribe consciousness of "right" and "wrong," and a feeling of freedom of choice in behavior. "*A-moral*" signifies the absence of these elements of personality, as in the behavior of young children, animals, the insane, and the physico-chemical forces of the universe.

It is perfectly true that we can cut off an arm or leg, remove certain peripheral ganglia and even a certain limited part of the central brain without seriously interfering with consciousness or personality. We can leave the brain structure anatomically intact, and through poisons eliminate consciousness temporarily or alter the individual personality permanently. The data from brain tumors, brain injuries, drugs, such as sedatives, hypnotics and anesthetics, experimental physiology, defective heredity, show that there is a close correspondence or dependence of consciousness, intelligence, memory or individuality on the nervous system.

What is personality? I think biologists would agree, to-day, that one element in personality is heredity, the kind of germplasm with which we are endowed at conception.

In the case of man and other mammals the original germplasm is subjected to months of intra-uterine environment. The latter is complex, not simple. Such material factors as the constitution, health and food of the mother appear to have a very real influence on the constitution of the fetus, and after birth such material factors as disease, accidental injuries, food, etc., may further materially modify the final product: man or woman.

The hereditary personality is further modified and built up gradually by experience and memory, so that to-day I am a somewhat different person from what I was twenty years ago. It seems at least highly probable, on the basis of biology, physiology and medicine, that this experience or the cumulative effect of the environment depends on changes built up mainly in the nervous system. The modifications of the nervous system called memory are less stable than the hereditary elements of the nervous organization. All the present evidence points to the fact that at death the nervous system goes to pieces with the rest of the body. Indeed, the disintegration of the nervous system, and with it the personality, may start before the death of the individual. The tragedies of "second childhood," of the aphasias, of senile dementia are known to all informed people. It doesn't make any difference whether the disintegration is fast or slow. We may preserve for a time some externals by desiccation, embalming or petrification. But fossils and mummies are as dead as the ashes of the funeral pyre. I can not conceive of events and environments in the future that would exactly reproduce my heredity and personal experience. Our basis of the known and the probable, immortality of the person is, at present, untenable. Leaving, for a moment, the realms of knowledge and reason and speaking of personal wishes, of likes and dislikes, the wish for personal immortality may be an extension of the pleasure in living, sometimes called "the will to live." The quantity of these emotions appears to vary in different people. Many seem to find comfort in the theory of "Nirvana," the state of everlasting unconsciousness. "Nirvana" may, without trickery or undue violence to reason, be translated into what modern biology indicates as the end of the individual, but the ways of attaining "Nirvana" appear to me incompatible with the good life here. As for other conditions of existence of the individual after death, other abodes of the "souls," the sundry infernos arouse in me, not fear, but pity and wonder how man can choose to torture his mind with such cruel absurdities; and I have not seen any heaven described where I care to go. My forebears had their Valhalla with its mead, its roast pork, its combats; the American Indian his happy hunting grounds; the followers of Mohammed their haven of houris; the Christian has his golden city of many apartments, his golden harp and his oriental worship of adulation. But hunting means destroying fellows not so very different from ourselves. A heaven of mead and pork and fights and females forever leaves me cold. Flowers, though they like ourselves last but for the moment, are finer than gold, and justice seems a better goal than worship. When the shadow lengthens I am content to call it a day and leave the work to others. The passing of personal immortality seems to have added interest to my work to-day, greater interest in my students, in my fellow men, in other things that seem worth-while human efforts. For when I die, I will be a long time dead.

I am perfectly well aware that many able and fine people inside and outside this hall will arise with impatience, if not in anger, and say: "Your analysis of the supernatural refers to an extinct species. It does not apply to religions or religious people of to-day. You are belaboring a man of straw." What are the facts? Is supernaturalism a thing of yesterday? Have the peoples of the earth ceased to chant every variant of the tune, "The old time religion is good enough for me"? If the orthodox Jew (and that embraces most of the Jews) has dethroned Jehovah, and rejected the Bible, I have not heard of it. According to the latest news the Pope is still God's viceroy among men and the faithful Roman Catholics still believe that the voice of the Vatican is the voice of God. The acceptance of the whole Bible as divine truth is not a rarity among Protestant Christians. The God of the Jews, the Christians and the Mohammedans in 1930 is not a fossil. Enter almost any religious service and you get an earfull of ancient and modern supernaturalism anent the soul, the devil, hell and heaven, sin, redemption, almighty Gods, angels, divine purposes, prayer. Is the supernatural

extinct? Take a look on and about this campus, and you will find a very prolific and very recent growth of chapels and churches: edifices, I am delighted to note, only in part dedicated to the rituals of the "God of old." To be sure the supernatural is not in our federal constitution. But it is not absent from state and municipal codes. "Acts of God" are embalmed in legal lore. Physiology and biology can not be taught at public expense in the states of Tennessee, Arkansas and Mississippi because it conflicts with "revelation." Is supernaturalism dead? What I have said here to-night would subject me to arrest and imprisonment in the state of Massachusetts, and disqualify me as a witness in court in at least six other states in the Union. Yes, my friends, supernaturalism is dead, indeed! Let a Jew, a Roman Catholic, a Mohammedan, or a man of no belief, like myself, run for governor in any state south of the Mason and Dixon line (and possibly in some states nearer home), or for President of the United States and he will discover something! The world has, indeed, moved since the days of Galileo, but in some places it has not moved very far. Why, the handful of liberal and informed people who have worked their way out of the cocoon of supernaturalism does not even make a respectable leaven in the college graduate group!

President Hoover, an engineer, and therefore at home in science, stated in his recent Thanksgiving proclamation: "We have been blessed with distinctive evidence of Divine favor. As a nation, we have suffered far less than other peoples from present world difficulties." This statement appears to imply that a divinity controls economic contingencies and rainfall, and either that we as a nation are morally more worthy than other peoples harder hit by economic and natural events of the past year, or else that this divinity is unfair in decreeing punishments and favors.

According to several Italian churchmen, the recent disastrous earthquakes in Italy were caused, not by unbalanced stresses in the crust of the earth, but by the Christian God, as punishment for the sins of men, women and little children in the devastated areas! Granted, for the sake of the argument, that the bishops are right and modern geology is wrong about earthquakes, we may still ask for evidence that men, women and little children living in earthquake areas are greater sinners than people living elsewhere; and again, if questioning was not tabu, how can a *just* and *loving* god institute such indiscriminate punishment? How can a *just* and *almighty* God permit such catastrophes to occur?

Within the present year five Protestant pastors in our neighboring state, Kentucky, are reported to have published the following statement: "God will and can answer prayer for rain. God has never withheld rain from the earth except in a gracious effort to bring his own people back to the ways of righteousness and holiness." If there is a God both almighty and just, prayer for rain and all kinds of favorable weather anywhere is unassailable. But if rain is sent to earth in proportion to holiness and prayer to Jehovah, the sundry heathens and all worshipers of "false gods" would have a dry time, not to speak of plants and animals who, according to the Bible, have no souls to pray with. Unfortunately for that kind of faith, the rainfall in heathen Philippines (that is, before the introduction of Christianity) was greater than in our Christian state of Tennessee. But this question need not be left in the realm of faith and controversy. It can be settled by controlled observation. What is the ratio of rainfall to Christian, Jewish, Mohammedan or Mormon prayers in various lands? The states of Washington and Oregon (west of the Cascades) have more rain than has the state of California (west of the Sierras). Is this difference due to the wickedness of Hollywood, and the past generation of gold diggers, and the holiness of the lumberjack? The adherents of the supernatural pray and irrigate the arid lands; others merely irrigate. The crops seem to parallel the irrigation rather than the prayers. Were it not for supernatural tabus, many other supernatural claims could be put to the experimental test. It should not be much more difficult to determine the efficacy of prayer against such diseases as syphilis, malaria, diabetes and goiter, than to establish the merits of arsenic, quinine, insulin and iodine. Not very long ago I read a signed public statement by a lady in the state of Kansas to the effect that she had seen a goiter melt away from the neck of another lady during the praying of the Reverend Aimee Semple McPherson directed toward this end. This appears like direct evidence. But metabolism tests, neck measurements and motion pictures of the "melting" process would go further to convince the skeptics. What people under intense emotions and desire to believe think they see has frequently no relation to the light that actually impinges on the retina. Intense faith as well as intense fear seem to predispose to hallucinations in many people.

The moral efficacy of infant and adult baptism could also be tested experimentally, although with less accuracy, until better quantitative measures of human character are worked out. A prominent physiologist told me he had done this experiment in his own family, having two of his children baptized, and keeping the other two children as controls. I will not even mention the results, for we draw no conclusion from so few experiments, but it might be pointed out that identical twins would be the best material for this test. Is supernaturalism dead? Some Protes-

tant clergymen inform us that Jehovah is a prohibitionist, and the people who oppose our present prohibition of alcoholic beverages are fighting God. Some of the Roman Catholics tell us that raising grapes and drinking wine is God's plan for man. Such confusion on the celestial lines of communication ought to provoke thought. It seems to induce nothing but reciprocal anger.

Many people take the position that science is well and good in the "material" world. They would exclude the method and attitude of science from certain fields of human life. A prominent New York rabbi said only a few days ago: "Human feelings and emotions will remain outside the scope of science forever." As if the biological sciences, including medicine, have not already produced a very respectable body of verifiable data on the mechanisms of the emotions. The relation of the brain to the emotions is nearly as clear as the relations of the kidneys to the secretion of urine or the relation of the gullet to swallowing. That complete obstruction of the gullet will prevent swallowing I do not think would be denied even by a rabbi. It is a favorite saying that there is more than science in the universe and in human life. We grant that. At the present the unknown exceeds the known. There is more ignorance than science. But is that a cause for exultation? Instead of wasting time and energy in the futile effort of building fences around science, and in a meticulous labeling of the "unknowable," we had better join hands in tackling the unknown, not with worship, prayer or propitiation, but with the tool of science. Here is useful and joyful work for everybody.

The Ethics of the Supernatural

May I make a few concluding remarks on the ethics of the supernatural, speaking not as a scientist but as a common man? The ethics of science is simple: absolute honesty in recording and presenting data, and curbing wishes, personal prejudices and emotions by reason in interpreting the data.

There appears to be a great variety of ethics in the supernatural. Looking upon the supernatural simply as man's early stumbling attempts at learning, at adjustment, as flounderings toward greater happiness, as quests for explanations of the unknown, this variety is both inevitable and understandable. From this point of view, the modern man of science has no essential quarrels with Jesus, Confucius, Zoroaster, or Buddha. They did the best they could, considering the ignorance of their times. We can do no more. But now and then individual champions of the supernatural have been either unusually stupid or inordinately selfish and cruel. The judgment of posterity will be severe on the men who coerced Galileo and their brethren of to-day who know or might know, yet rivet the shackles of supernaturalism on the human mind. For they sin against man. It is significant that neither Jesus nor his apostles appear to have claimed any supernatural authority or absolute wisdom for their sayings or writings. The ignoble doctrine of divine revelation of absolute truth for all times appears to be a later invention. But in Mormonism and Mohammedanism it is present with the founders. I said: ignoble doctrine. Intellectual tyranny is to me as immoral as physical tyranny. Stifling freedom of inquiry and of thinking by religious tabus or legal dicta appears to me highly immoral.

The view or belief that some one man or group of men (such as Brahmins, popes, priests, etc.), above all other humans, is specially endowed or enlightened to perpetuate and advance truth, and mediate between gods and man favors tyranny. It seems inimical to knowledge and human dignity, hence immoral.

The supernatural theories of "sin," personified evil, redemption, eternal damnation, etc., when actually believed, have created and are creating much disturbance in man's emotional life, in the way of fear, worry, melancholy, if not outright insanity. The theory or doctrine of the vicarious atonement in the Christian religion is not only a projection of views and practices of barbarism into modern life, but it connotes a principle of punishment and propitiation at variance with modern sense of justice. It goes without saying that many Christian people are not aware of this.

If we take a look at the gods, they can be understood and condoned as inventions of man, at varying stages of social development. The fossilization of nearly all so-called sacred books by edicts and tradition has brought about the anomalous condition that the best people in many religions to-day are ethically superior to their gods. In the recent invasion of Palestine the modern Israelites have shown themselves in treatment of the Arabs, by and large, superior to Jehovah of the Bible.

If man as well as his social environment remained stationary, static mores might serve very well. But social, economic and political life appears to be more fluid than man. Hence the necessity of continuous amendment of the mores. For example, the travail of modern life is forcing the practice of birth control into the open for a more rational and humane settlement, despite the thunders from Mount Sinai and the echoes thereof from the Vatican Hill. If a physiologist, in 1930, may venture to reinterpret the aphorism of Paul, anent faith, hope and charity, it would read something like this: Faith is of the past, hope must be chastened by experience, charity in mod-

ern garb, is misdirected benevolence. But there remains the endeavor towards understanding, the hunger for beauty, the urge for justice—these three, and the greatest of the three is justice.

Science nurtures inquiry, the supernatural stifles it. The two are in their very essence incompatible, but they can apparently coexist in some scientists of the first rank. Man is, indeed, a perplexing animal. He is rarely consistently consistent or consistently inconsistent. The crook is not always crooked, the murderer not always cruel, the thief not always greedy. An honorable person may lie and a liar sometimes tells the truth. A shrewd business man may consult a soothsayer and be afraid of a black cat. Most men in early childhood are emotionally conditioned to the supernatural, just as they become emotionally conditioned to other elements of childhood environment: parents, places, playmates, nursery rhymes, the old swimming hole, and what not. Retaining and recalling these emotions please us. Adults may be conditioned, but usually with less emotional content than the child. We can be conditioned to science or justice just as to the supernatural, but the latter usually gets there first. The conditioned emotions usually outlive one's intellectual metamorphosis. Their disappearance seems to be a slow atrophy of disuse. Many factors appear to enter into the persistence of early conditioning to the supernatural, such as group loyalty, the desire to conform to social usage, the disinclination to disturb or distress parents and other intimate friends; social, political and financial ambitions, etc. Men also appear to differ in the emotional satisfaction obtained from the mystic. Additional factors, such as individual emotional capacity, may be operative in making some scientists think and work, while others think and work and pray. I admit it may be easier for men in the physical sciences than for biologists to cling to the supernatural, for much of the grotesque in the supernatural concerns man and other living things rather than inanimate nature. But even so, it is a fact that Rev. Stephen Hale laid the foundation for the science of hemodynamics, and Friar Mendel discovered fundamental principles in heredity. So far as I know, the Reverend Hale and Friar Mendel were sincere adherents of their respective religious cults. Our social heritage, good, bad and indifferent, clings to us like the hand and the appendix of organic inheritance. Hence, like the proverbial Englishman, we "muddle" but, now and then, we "muddle through." Fear and faith have ruled much of man's past, but the millennium is still far, far away. Now let us try what may be accomplished by undertaking. Give science a chance.

I seem to sense a silent sigh from you, saying: "Thank God, he is through." I am—nearly. Knowing next to nothing about public speaking I consulted an experienced colleague, before preparing this talk. He referred me to a well-known canon, which reads: First, you tell your audience what you intend to tell, then you proceed to tell it, and lastly you tell what you have just told. You may have observed that I have followed this advice. I have now reached the lastly. Lest I be accused of hiding my real views in a plethora of verbiage, I will attempt to sum up, in threescore words, what I tried to say in seven thousand: As I see it, the supernatural has no support in science, it is incompatible with science, it is frequently an active foe of science. It is unnecessary for the good life. And yet, the supernatural, in varying dilutions, is likely to persist in society for a very long time. The unconditioning and reconditioning of mankind in fundamentals has been a slow process in the past. It may go a little faster in the future. It is a matter of forgetting the hypothetical universe created out of ignorance and motivated by our undisciplined emotions; and a reconditioning to the actual universe, as gradually understood through controlled experience and experiment.

COPE: MASTER NATURALIST[1]

By Dr. HENRY FAIRFIELD OSBORN

PRESIDENT OF THE AMERICAN MUSEUM OF NATURAL HISTORY

AMERICA is slow to recognize her own great men. Along the entablatures of our scientific buildings as well as of our public libraries are enrolled all the greater names in the long intellectual history of man beginning with the Greeks, but these tributes stop short when it comes to the enrolment of great Americans. We have shown so little appreciation of the life of the subject of this volume that his name is not even mentioned in the recent encyclopaedias which contain many lesser American names. In this case it is not difficult to find at least a partial explanation. Cope was never on the side of the great powers of the period either in science or in government, for both

[1] Foreword of a volume soon to appear from the Princeton University Press entitled "Cope: Master Naturalist, the Life and Letters of Edward Drinker Cope," text 590 pages, classified bibliography of 150 pages and 1395 titles, by Henry Fairfield Osborn, assisted by Helen Ann Warren as editor and co-author. The volume is a sequel to the author's "Biographical Memoir of Edward Drinker Cope, 1840–1897," published by the National Academy of Sciences in 1930.

in intellectual equipment and in life history there is a strong parallel between Cope and his great French Revolutionary predecessor, Lamarck. Both were men of genius; both were innovators in the classification of the animal kingdom; both rendered great service to the science of zoology; both failed of contemporary scientific and political support; both ended their lives in poverty and more or less obscurity. May the publication of this volume have at least one great result, namely, that posthumous justice be done to Cope as it has been done to Lamarck, and that his name be enrolled as one of the master naturalists of all time.

The preparation of this volume has been a labor of love, practically beginning a month or so before Cope's death in the year 1897 with my insistence that he should begin to prepare his own bibliography. During the thirty-three succeeding years step after step has been taken in the preparation of this volume, aided by many willing and able coadjutors both in the extremely arduous preparation of a bibliography of such length and complexity as has never been known before and in the no less arduous preparation of the biography which began with many contributions from Cope's contemporaries in the year 1897. It reached this final phase by close, continuous and active work on the part of a recent graduate of Barnard College, Helen Ann Warren, an excellent exponent of the advantages of the higher education of women, so strongly advocated by Cope, and a graduate of an institution endeared to the present author by the lifelong devotion of Lucretia Perry Osborn to its interests.

Soon after Cope's death his beloved daughter, Julia Cope Collins, whose name figures largely throughout his correspondence, presented to the American Museum Cope's complete personal library of his own publications. This furnished the backbone of the bibliography. A greater mark of confidence was the deposit in the American Museum of the lifelong correspondence of Cope with his family, including intimate letters which throw an entirely new light on his personality. The first duty of Miss Warren was to copy these letters from the beginning to the end, thereby creating a picture of Cope's whole life story. The letters were written in brilliant style; they form a priceless picture of the United States in the Civil and post-Civil War period. They allude to the trials and hardships as well as the ambitious and rivalries inevitable in the pioneer western period in which Cope was working. While many strictly family references have been omitted from the letters in Chapters II to VI and such omissions are partly indicated by dots, a great many matters including Cope's high or low opinions of other men and defenses of his own lines of conduct are included. The omission of some of these passages perhaps might have placed Cope in a more angelic light. On the other hand, such omissions would not have given a true biography, so, with the full permission of Cope's family, they are included. We feel confident that the true light on personality is always the best light and that many who have hitherto misunderstood the character of Cope will be more charitable in their judgments and more full of admiration for the many fine sides of his character. Another reason for extensive quotation of the letters is that the family have lent very substantial aid in the preparation of this volume and will naturally welcome and enjoy the family side of Cope's life history.

Now that the hard thirty-three years' work in the preparation of this volume is drawing to a close, the author desires to express his heartfelt appreciation of all those who have cooperated in bringing it to completion. Their names are partly recited above and again in full throughout this volume. They are given fullest credit at every appropriate point throughout the work and are included in the following list of biographers and bibliographers:

Biography

Theodore Gill, 1897
Persifor Frazer, 1897
Julia Cope Collins, 1897–1931
William H. Collins, 1926
William Berryman Scott, 1897–1931, Geology and Paleontology
William Diller Matthew, 1897–1930, Paleontology
George Gaylord Simpson, 1929–1930, Paleontology
William King Gregory, 1930–1931, Ichthyology and Phylogeny
E. W. Gudger, 1930–1931, Ichthyology
G. Kingsley Noble, 1930, Herpetology
Barnum Brown, 1930, Paleontology
Frederic A. Lucas, 1928, Paleontology
Charles C. Mook, Geology
George Gaylord Simpson, 1929, Map of Cope's Journeys
John Germann, 1929–1930, Map of Cope's Journeys
Florence Milligan, 1925
Johanna Kroeber Mosenthal, 1913

Bibliography

Anna M. Brown, 1897–1899
Jannette May Lucas, 1915–1931
E. W. Gudger, 1924–1931
G. Kingsley Noble, 1920–1931
Robert T. Hatt, 1931
Barnum Brown, 1931
George Gaylord Simpson, 1930
Walter Granger, 1930
W. B. Veazie, 1917–1921
Paul Brockett, 1929–1930
William Diller Matthew, 1897–1930

Financial Aid

Julia Cope Collins
Mrs. Philip C. Garrett
The Cope Family
Henry Fairfield Osborn
The American Museum of Natural History

The work of my co-author and editor, Miss Helen Ann Warren, should be especially praised not only for its thoroughness and accuracy but for the rare quality of sustained interest and enthusiasm for the subject shown, especially in the introductory chapter entitled "Pioneers of Paleontology in America" which is very largely her own assemblage and writing, guided, of course, by the author, also in the biographic narrative of Chapter II which from the standpoint of the newer education seems the most opportune in this biography. The old education seems to have been altogether ideal in the case of Cope. Then we pass to Cope's experience in the university of the world and find him fully equipped for his great career.

I am confident that all who have taken part in the preparation of this volume will feel fully rewarded by the thought that they have helped to write a great chapter in the history of American science, namely, of a period covering the lives and labors of our three founders of vertebrate paleontology, Leidy, Marsh and Cope, a branch of science in which America has won a place of honor and esteem throughout the world. I trust also that this volume will firmly establish the permanent reputation of Edward Drinker Cope as a "Master Naturalist."

SCIENTIFIC EVENTS

THE BALTIC GEODETIC COMMISSION

The Baltic Geodetic Commission is an organization for dealing with the geodetic problems of the many nations surrounding the Baltic Sea. It recognizes the fact that geodesy is no respecter of national frontiers. The nine member countries are Denmark, Esthonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. The fifth conference of the commission was held in Copenhagen last October. The member nations, except Russia, were all represented by accredited delegates, and in addition Norway and Austria were represented by invited guests. Six sessions were held for the consideration of business matters and reports; scientific papers were also presented and visits made to scientific institutions in and near Copenhagen.

The Baltic Commission has already gained a high reputation for the careful geodetic work done under its auspices and for its high scientific standards. The comparatively small number of its members, their nearness to one another and the frequency of the meetings all contribute to the close cooperation and to the interchange of experience that are so favorable to good work and rapid progress.

The commission is, however, considering the widening of its field of work. According to the convention establishing the commission any country desiring to join the commission is entitled to do so. At the Copenhagen meeting, moreover, there was some discussion of a very ambitious project that far transcends the geodetic survey of the Baltic area, namely, the extension of the existing geodetic arc along the 52nd parallel in Europe into Asia as far as Bering Strait and thence across the strait into Alaska, where it would connect with Alaskan triangulation, which in turn will soon be connected with geodetic triangulation in Canada. In this way the longest geodetic arc in the world would be formed. This would be a great achievement, but it will probably be some time before such a scheme can be carried out. Even the existing portion of the arc in Europe needs to be strengthened in various ways and it is still to be proved that it is feasible to make an adequate geodetic connection across Bering Strait.

Professor Kohlschütter, of Potsdam, was elected president, succeeding Professor Nörlund, of Copenhagen, who was chosen vice-president. Professor Bonsdorff, of Helsinki, continues to serve as general secretary.

The information on which this notice is based was supplied in part by Professor Schumann, of Vienna, who attended the meeting as a guest and representative of Austria.

W. D. L.

THE INTERNATIONAL BIOLOGICAL CONGRESS AT MONTEVIDEO

From October 8 to 12 there was held at Montevideo a Biological Congress as one of the events designed to celebrate the centenary of Uruguayan independence. A Medical Congress ran concurrently. The national government assisted those in charge by providing honoraria for a number of foreign delegates. Among these were Professor Gustav Embden, of Frankfort; Professor Pedro Rondoni, of Milan; Professor Claude Regaud and A. Mawas, of Paris; Professor Wolfgang Koehler, of Berlin, and Professor Edwin Baur, of Munich. Each South American country sent delegates representing its institutions. There were probably 200 in attendance. Plenary sessions were held each morning. The afternoons were devoted to visits to laboratories, museums and other institutions of local significance, while the evenings were used for sectional

meetings. Addresses were given at the plenary sessions by foreign delegates and other invited members. The sections represented were (1) general biology; (2) cytology, histology, embryology and anatomy; (3) physiology and biochemistry; (4) parasitology, microbiology, hematology and serology; (5) methods and didactics of the biological sciences. The general interest of South American biologists is probably well indicated by the names of the sections and by the numbers of papers given in each. At the plenary sessions 30 papers were presented; in section 1, 26 papers; section 2, 63; section 3, 101; section 4, 93; section 5, 9. Supplementary programs added 22 papers, making a total of 344. The strong medical cast of biology here is apparent in these figures and in the absence of such categories as genetics, ecology, etc.

The officers of the congress were: *President,* Clemente Estable; *Secretary,* Benigno Varela Fuentes; *Treasurer,* Julio E. Moreau. Additional members of the *Executive Committee* were Drs. Apolo, Cordero, Prunell, Pucci, Guerrero and Rubino. For each country in South America represented there was an executive committee and the membership in these is an index to the working forces in biology there. The largest foreign attendance was naturally from Argentina and Brazil. This first Biological Congress was so successful that it was voted to hold a second in Rio de Janeiro two years hence under the presidency of Professor Miguel Ozorio de Almeida. Attendance of North American biologists would, I am sure, bring them much pleasure and considerable surprise at the amount and character of biological work being done south of the Caribbean.

C. E. McClung

LECTURES OF THE PHILADELPHIA ACADEMY OF NATURAL SCIENCES

The Ludwick free lectures were given in the auditorium of the Philadelphia Academy of Natural Sciences during January and February and will continue through March. These consist of twelve Monday evening and eight Sunday afternoon lectures, the speakers and their subjects being as follows:

Francis R. Cope, Jr., "New Zealand for the Nature Lover."

Dr. Clyde Fisher, of the American Museum of Natural History, New York, "Wild Flowers of Spring."

Dr. William E. Hughes, research associate, "Honolulu."

Dr. S. A. Barrett, director of the Milwaukee Public Museum, "Tamest Africa."

Captain James Sawders, of Pittsburgh, "The Wonderland of Mexico."

Barnum Brown, of the American Museum of Natural History, New York, "Searching for Prehistoric Life in Arizona."

Dr. Witmer Stone, vice-president, "Bird Life of the New Jersey Sea Coast, Past and Present."

Samuel G. Gordon, "Across South America and Africa."

James A. G. Rehn, secretary, "A Naturalist in Honduras."

Lester W. Strock, "By Pack Train Through the Canadian Mountains."

Henry W. Fowler, "A Glimpse of Maritime China and Japan."

Wharton Huber, "Across Canada to the Queen Charlotte Islands."

The Sunday afternoon lectures were as follows:

Dr. Henry A. Pilsbry, curator of mollusks and marine invertebrates, "Shell Fish and Other Invertebrates of the Seashore of New Jersey."

James A. G. Rehn, associate curator of entomology, "Insects—Beauties and Pests Found Near Philadelphia."

Henry W. Fowler, associate curator of vertebrate zoology, "Fishes, Their Life in the Waters Around Philadelphia."

Dr. Emmett R. Dunn, of Haverford College, "Reptiles and Amphibians, Modern Relatives of Ancient Races."

Dr. Witmer Stone, curator of vertebrate zoology, "Bird Life in Springtime."

J. Fletcher Street, "Wild Flowers of the Philadelphia Region."

Wharton Huber, associate curator of vertebrate zoology, "Familiar Mammals of Pennsylvania and New Jersey."

Dr. Henry A. Pilsbry, "Animals of the Ancient Past."

The Monday evening lectures begin at 8 o'clock and the Sunday afternoon lectures at 3 o'clock.

THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

The Federation of American Societies for Experimental Biology formed by the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology, will meet at the McGill University, Montreal, Canada, from April 8 to 11, 1931. The preliminary program follows:

Wednesday, April 8.—The members are invited to visit various laboratories and points of interest in Montreal. Meetings of the Executive Committee of the Federation and of the Councils of the Societies.

Thursday, April 9.—Joint Session of the Federation and Scientific and Business Sessions of the Societies. A complimentary banquet will be tendered the members in the evening.

Friday, April 10.—Scientific and Business Sessions of the Societies. Joint Demonstrations 2:00 P. M. General Meeting of the American Society of Biological Chemists at 3:30 P. M. The annual banquet

of the federation will be held at the Mount Royal Hotel at 8:00 P. M.

Saturday, April 11.—Scientific Sessions of the Societies. Joint Session of the Federation. A detailed program will be mailed from the office of the secretary of the federation.

The headquarters are the Mount Royal Hotel, Peel Street. A special registration and information bureau will be located on the ninth floor, and also a railroad ticket office, where certificates can be validated and where tickets can be purchased. All members should register at the bureau as soon as possible after arrival and should deposit their railroad certificates for validation. The Mount Royal Hotel can probably accommodate all members who attend. It offers a flat rate of three dollars per person. Requests for reservations should be directed to the Mount Royal Hotel, Peel Street, Montreal. Information in regard to other hotels can be obtained from the secretary. On each day of the meetings table d'hote luncheons will be served at the Mount Royal Hotel at a price of one dollar per person.

A reduced fare on the "Certificate Plan" of one and one half fares for round trip to and from Montreal will apply to members and associate members (and their dependent families) of the Federation of American Societies for Experimental Biology and affiliated societies, provided over 150 members present certificates.

The local committee in charge of arrangements consists of Drs. J. B. Collip, *chairman;* B. Babkin, N. Giblin, F. E. Lloyd, C. N. H. Long, J. C. Meakins, E. G. D. Murray, H. Oertel, R. L. Stehle, John Tait, D. L. Thomson, T. R. Waugh and D. R. Webster. Arrangements for demonstrations are in the hands of Dr. John Tait, physiology; Dr. D. L. Thomson, biochemistry; Dr. R. L. Stehle, pharmacology, and Dr. T. R. Waugh, pathology.

Any requests should be addressed to Dr. J. B. Collip, chairman of the Local Committee.

HOWARD B. LEWIS, *Secretary,*
University of Michigan,
Medical School,
Ann Arbor, Michigan

THE PASADENA MEETING OF THE AMERICAN ASSOCIATION AND THE ASSOCIATED SOCIETIES

PLANS for the first regular summer meeting of the American Association for the Advancement of Science, to be held at Pasadena, California, from Monday, June 15, to the following Saturday, are rapidly taking shape. The California Institute of Technology, Mount Wilson Observatory and the Huntington Library and Art Gallery are hosts for this meeting and are cooperating with the Los Angeles Chamber of Commerce and the American Association for the Advancement of Science to make it exceptionally large and successful in every way. Arrangements for the meeting are in the hands of a local committee composed of Paul W. Merrill, *chairman,* Harold D. Babcock, *secretary,* John P. Buwalda, E. C. Watson, Linus Pauling and R. O. Schad.

A group of men of national and international reputation will deliver a series of six evening lectures during the meeting. The list of invited speakers includes outstanding authorities in their particular fields of research. It appears that all sections of the association will be represented in the program. Section B (Physics) and the American Physical Society are planning a four-day meeting. A program committee in charge of physics has already taken active steps and has supplied an impressive list of prominent European physicists who expect to be in California this summer.

Other national societies which are planning to meet with the association are: the Illuminating Engineering Society, the American Association of Economic Entomologists (Pacific Slope Branch), the American Chemical Society (Pacific Intersectional Division), the American Meteorological Society, the American Physical Society, the American Phytopathological Society (Pacific Division), the Astronomical Society of the Pacific, the Botanical Society of America (Pacific Section), the Ecological Society of America, the Society of American Bacteriologists, the Society for Experimental Biology and Medicine (Pacific Coast Branch), and the American Society of Plant Physiologists. The following local organizations are also planning to hold sessions: California State Veterinary Medical Association, the Cooper Ornithological Club (Northern Section and Southern Section), the Lorquin Entomological Society, the Pacific Coast Entomological Society, the San Francisco Aquarium Society and the Western Society of Naturalists.

It is hoped that the morning sessions only will be devoted to the reading of papers by the associated societies and sections and that the afternoons will be devoted to excursions to near-by points of interest. Low excursion rates from nearly all parts of the United States will be available.

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the National Academy of Sciences will be held in the building of the academy in Washington from April 27 to 29 under the presidency of Professor T. H. Morgan, of the California Institute of Technology. The four-year term of the officers expires at the meeting. Professor A. A. Michelson and Professor William H. Welch are the only living former presidents of the academy.

THE executive committee of the American Association for the Advancement of Science will meet in Washington on April 26. Business relating to the Pasadena and New Orleans meetings or other activities of the association should be communicated to the permanent secretary in the building of the Smithsonian Institution, Washington, D. C.

THE Franklin Medal for 1931 will be conferred on Sir James Hopwood Jeans, secretary of the Royal Society from 1919 to 1929, and on Dr. Willis R. Whitney, director of the Research Laboratory of the General Electric Company at Schenectady, New York. The medals will be presented at the institute's Medal Day exercises on May 20.

THE Astronomical Society of the Pacific has awarded its Catherine Wolfe Bruce Gold Medal "for distinguished services to astronomy" to Dr. Willem de Sitter, director of the Observatory at Leiden, Holland.

THE council of the British Institution of Electrical Engineers has made the tenth award of the Faraday Medal to Mr. Charles H. Merz, consulting engineer and senior partner of Merz and McLellan. The Faraday Medal is awarded not more frequently than once a year either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence, or membership of the institution.

THE Dalton Medal of the Manchester Literary and Philosophical Society has been awarded to Sir J. J. Thomson. The presentation will be made on the occasion of the delivery of the Dalton Lecture before the society on March 17.

SIR D'ARCY POWER, who has returned to England from lecturing in America, has been presented with a volume of selected writings from his own work in commemoration of his seventy-fifth birthday. The presentation was made at Sir D'Arcy's hospital, St. Bartholomew's, by Lord Moynihan, who described him as the most eminent medical historian of our day.

DR. P. COPANARIS, director of hygiene of the Republic of Greece, was tendered a banquet by the city of Savannah, Georgia, on February 3. Dr. Copanaris has been visiting health departments in America as the guest of the International Health Division of the Rockefeller Foundation.

Nature writes as follows: "The University of St. Andrews has sent its congratulations to Dr. W. W. Keen, of Philadelphia, one of its honorary graduates, on his attainment, on January 19, of the age of ninety-four years. It is twenty-three years since Dr. Keen resigned the professorship of surgery at Jefferson Medical College. The honorary degree of LL.D. was conferred upon him by the University of St. Andrews in 1911, during the celebration of the five-hundredth anniversary of the foundation of the university. Dr. Keen's longevity and cheerful hardihood are matched by those of Emeritus Professor W. C. M'Intosh, also of St. Andrews, who is ninety-two years of age and is still busy with scientific work."

AT the recent meeting of the Georgia Academy of Sciences, Mr. R. D. Kneale, industrial engineer at Atlanta, Georgia, was elected *president;* Dr. Alfred W. Scott, head of the department of chemistry of the University of Georgia, *vice-president;* Dr. George H. Boyd, head of the department of zoology, University of Georgia, is *secretary-treasurer.* Dr. Karl K. Darrow, of the Bell Laboratories of the American Telephone and Telegraph Company, made the principal address. He spoke on "X-Rays and Electricity as Waves." The membership was raised from 60 to 70.

MR. ROBERT E. TALLY, vice-president and general manager of the United Verde Copper Company, has been elected president of the American Institute of Mining and Metallurgical Engineers at the recent New York City meeting. Mr. H. A. Guess, of the American Smelting and Refining Company, and Mr. Howard N. Eavenson, of Howard N. Eavenson and Associates, Pittsburgh, were elected vice-presidents.

AT the annual meeting of the Royal Microscopical Society, held on January 21, Professor R. Ruggles Gates was elected president.

THE first president of the Social Science Research Council, Dr. Edwin B. Wilson, professor of vital statistics in Harvard University, after serving for a year and a half, has been succeeded by Dr. Robert S. Woodworth, professor of psychology in Columbia University, who is expected to serve for a similar term, and who will continue to carry a part of his university work.

DR. FRED JENNER HODGES, lecturer in radiology in the University of Wisconsin Medical School, has been appointed professor of roentgenology at the University of Michigan, to succeed the late Dr. Preston M. Hickey.

THE corporation of the Polytechnic Institute of Brooklyn has reappointed Professor Vladimir Karapetoff, of Cornell University, as visiting professor of electrical engineering for part-time service at the Polytechnic for the year 1931–1932 and has given permanent appointment as research professor of electrical engineering to Dr. Ernst Weber, of the Technische Hochschule of Charlottenburg-Berlin, who is at the Polytechnic Institute this year as visiting

professor of electrical engineering. Both Professor Karapetoff and Professor Weber will devote their efforts to the development of graduate evening study and the encouragement of research activities in the field of electricity.

MR. CONRAD L. WIRTH has been appointed assistant director of the National Park Service in charge of the branch of lands to succeed the late Mr. W. B. Lewis.

FOR the purpose of advising the British Minister of Health on the practical application of modern advances in the knowledge of nutrition, an advisory committee has been appointed comprising the following members: Professor Major Greenwood, *chairman;* Professor E. P. Cathcart, Sir F. Gowland Hopkins, Miss Jessie Lindsay, Professor E. Mellanby and Professor V. H. Mottram. The members will hold office until December 31, 1933, and will be eligible for reappointment. The secretary to the committee will be Mr. F. R. Hudson, of the Ministry of Health.

DR. R. R. WOOLEY, second-year fellow in astronomy at the California Institute of Technology, has been appointed to an Isaac Newton Scholarship in astronomy at the University of Cambridge, and will continue his studies there next year.

MR. STANLEY F. MORSE, consulting agricultural engineer of South Carolina and New York City, who is making a business trip and studying agricultural economic conditions in England, France, Spain and Italy, has completed an inspection and report of a 150,000-acre irrigation project in southern Spain.

DR. M. A. JOSLYN, research assistant in fruit products, University of California College of Agriculture, has been given leave of absence for six months to aid in the inauguration of a plant for the production of frozen orange juice in Florida.

A COURSE of lectures on Photographic Theory at the Institute of Applied Optics, Rochester, New York, is being given by Dr. C. E. K. Mees, Dr. K. C. D. Hickman, Dr. E. P. Wightman, Mr. J. I. Crabtree and Mr. L. A. Jones. The lectures are given on consecutive Fridays. They began on February 6. In addition to the lectures listed, a laboratory course has been arranged by Mr. Russell and Mr. Westwater, of the Kodak Park Laboratories.

DR. ARNOLD K. BALLS, lecturer in biochemistry at the University of Prague, lectured recently on "Recent Advances in Enzyme Chemistry" at Columbia University, the Rockefeller Institute, the University of Pennsylvania and the Pennsylvania State College.

PROFESSOR ALFRED C. REDFIELD, of the department of physiology of the Harvard Medical School, has accepted appointment to lecture in March at the Belgian universities under the auspices of the C. R. B. Educational Foundation. Professor Redfield will lecture in French on "Some Aspects of the Problem of the Evolution of the Respiratory Function of the Blood," and in English on "The Equilibrium between Oxygen and Hemocyanin."

AT the request of M. Briand, the minister of foreign affairs, who desires to promote the international exchange of university professors, the French minister of public instruction requested the council of the Faculté de Paris to designate an eminent professor who would be invited to lecture at the University of Paris. Accordingly Professor Jadassohn, of Germany, delivered three lectures on dermatosyphilography.

THE forty-sixth meeting of the American Astronomical Society, on the invitation of Professor Harlan True Stetson, will be held at the Perkins Observatory, Ohio Wesleyan University, Delaware, Ohio, on September 7, 8 and 9.

THE annual meeting of the American Society of Zoologists for 1931 will be held in New Orleans, La., December 29 to 31, inclusive, in affiliation with the American Association for the Advancement of Science. Joint sessions with closely related societies will again be features of the meeting.

A SOIL FERTILITY CONFERENCE commemorating the fiftieth anniversary of the soil fertility plots at the Pennsylvania State College will be held on June 24, 25 and 26. The college and experiment station staff, assisted by eminent soil technologists of other institutions, will present a technical program based on many detailed studies of these old plots. There will be two half days devoted to technical papers, two half days to excursions over the plots, college farms and outlying soil fertility projects, and one half day to an open forum on soil fertility problems. Special inspection trips to the orchard and gardens will be arranged. Dr. W. H. Jordan, who laid out these old plots fifty years ago, will be the guest of honor and will give an address. An official program will be issued three months in advance of the conference. Invitations will also be sent to all the Land Grant Colleges, the U. S. Department of Agriculture and to other research agencies, including many prominent soil technologists in the United States, Canada and European countries. The conference will not be limited to invitation; a cordial welcome is extended to all those interested.

Industrial and Engineering Chemistry reports that the opening of the Oscar Johnson Institute in St. Louis in January has made available facilities for research in diseases of the eye, ear, nose and throat. The institute, founded in memory of the late Oscar

Johnson, shoe manufacturer, was completed at a cost of $1,500,000, including equipment. The staff includes specialists in physics, physical chemistry and bio-chemistry, bacteriology and immunology, physiology, anatomy and pathology. The facilities of the institute will be at the disposal of any research worker who has a significant problem and the personal equipment to attack it. Research and teaching are endowed by the General Education Board. In addition, specific investigations of chronic and progressive deafness and an exhaustive program of trachoma research are being financed.

The trustees of Battelle Memorial Institute, Columbus, Ohio, have announced the establishment at the institute of a research project sponsored by the Calumet & Hecla Consolidated Copper Company, of Calumet, Michigan. The purpose of this project is to make a fundamental study of arsenical and argentiferous lake copper in respect to its properties and application to industrial uses. It has long been recognized that copper containing small amounts of arsenic and silver has definite well-defined advantages and recent developments have brought to mind the possibilities of further industrial applications. This research program is comprehensive in character and is in a most promising and fertile field. Mr. G. L. Craig has been added to the staff for work on this project, which is under the direct supervision of Dr. H. W. Russell and Mr. J. L. Gregg. Mr. Craig was formerly research fellow with the U. S. Bureau of Mines and more recently metallurgist for the Fairmont Aluminum Company.

Dr. N. P. Colwell, secretary of the Council on Medical Education and Hospitals of the American Medical Association, has notified President E. Everett Cortright, of the Junior College of Connecticut, that that institution has been placed on the list of approved colleges of arts and sciences for the two years of pre-medical education prescribed by the association.

The correspondent of the London *Times* at Riga writes under date of February 8, "The Soviet Press is making a charge of counter-revolution against Professor Karpinsky, the president of the Academy of Science of Leningrad. The basis of the charge is that he objected to the expulsion of the Academicians Platonoff, Tarle, Likhacheff and Liubavsky. The academy summoned an extraordinary meeting last Monday for the purpose of obtaining an explanation from Professor Karpinsky, who is 85 years old. He made a speech in which he expressed regret that the academy had become the mere servant of a single party and a single doctrine, and had lost the measure of freedom and independence it had formerly enjoyed. Everywhere else, he said, the word 'Academy' signified a collection of men with all sorts of religions, individual views and individual opinions, but the academy in Leningrad had lost its status and had become a mere department of the Communist Party. He demanded the restoration of 'freedom of conscience and freedom of opinion' for academicians and the removal from its statutes of the recently introduced Paragraph 19, which had been 'forced on the academy by the Soviet government,' and under which Platonoff and the others were expelled for alleged political untrustworthiness. According to the published report of the proceedings Professor Karpinsky stood alone. The majority present were silent, but several new 'Red' academicians spoke, rebuking their president for his contemptuous attitude towards the Communist Party and disloyalty to the government. The Leningrad *Pravda* declares that at last Professor Karpinsky has unmasked his counter-revolutionary face, and stands revealed as an enemy of the proletariat, and the mouthpiece of reactionary forces."

Patents assigned to the Ohio State University which are the outgrowth of researches made by the university should be dedicated to the public of the state, according to an opinion of the Attorney-General, Gilbert Bettman. The summary of the opinion, given to George W. Rightmire, president of the university, follows: "Where the Ohio State University becomes possessed of a patent by assignment from the nominal patentee, which patent is the outgrowth of researches made by the Engineering Experiment Station of the university, the said university, through its proper officials, should dedicate said patent to the public of the State of Ohio."

A new national forest, the Hiawatha, with a gross area of 270,071 acres in the heart of the Upper Peninsula of Michigan, comes into being by proclamation of President Hoover. This brings the total number of national forests up to 150, and the forest becomes part of the vast area of over 160,000,000 acres administered by the Forest Service. The 179,719 acres within the boundaries of the Hiawatha which remain in private ownership are to be acquired by purchase as rapidly as agreements are reached with the owners and funds are made available by Congress. Practically the entire area is covered with forest growth. Little virgin timber of large size is left, since most of the land was cut-over or culled many years ago. Fires have also ravaged much of it, so that at present the stand over large areas is aspen. The aspen growth, however, will make a good protective cover for young white pine and Norway pine, to which the land is adapted. The area has considerable recreational value, but there is little land of value for farming within its

boundaries. The boundaries of the Hiawatha National Forest take in an area extending about 18 miles from north to south and 24 miles from east to west. Headquarters for the new forest, formerly known as the Mackinac purchase unit, will remain at Munising, Michigan. Under Forest Service administration, the Hiawatha National Forest will be protected and developed for its timber growing, recreational and other public forest values.

During the Pennsylvania Farm Show held recently at Harrisburg, the Pennsylvania Topographic and Geologic Survey displayed a series of exhibits designed primarily to illustrate the value and use of a survey of this type to the layman. A number of topographic maps showed various physiographic types found in the state. Other maps portrayed the geology, soils and mineral resources of Pennsylvania. A series of wall charts illustrated the state's position as a producer of mineral wealth. Upon tables were exhibits including examples of publications by the survey, minerals common to the state, common rocks and minerals often mistaken for valuable ores, and building stones. By means of specimens and photographs attention was called to the development of limestone caves, the exploitation of which for the tourist trade is a growing industry. Another series of specimens illustrated how fossils form and how they may be used in the search for mineral wealth. Throughout the five days that the Farm Show was open, one or more members of the survey was present to explain further the exhibits to those interested. Of the quarter million people who attended, it is estimated that not less than 10,000 persons inspected the survey's displays.

Nature reports that the Society for Cultural Relations with Soviet Russia is considering the possibility of organizing in Great Britain a tour of scientific institutes in Soviet Russia during July and August, 1931. It is proposed to arrange for parties of British scientific workers engaged in physical, biological and medical research to visit and meet Russian workers engaged in similar researches. V.O.K.S., the central institution in Moscow for organizing cultural relations with foreign countries, is prepared to do everything possible to help the tour, and Intourist, the Soviet organization for tourist parties, will consider giving specially reduced traveling charges. Scientific workers desirous of joining such a tour are invited to write to the secretary, Society for Cultural Relations with Russia, 1 Montague Street, London, W.C.1.

The dean of the Medical Faculty of the University of Vienna, Austria, has notified the American ministry at Vienna that American citizens who file application to become regular students in the medical department must have the degree of bachelor of science or bachelor of arts. In addition, prospective students must comply with the minimum American requirement; that is, twelve hours of chemistry, eight hours of biology and eight hours of physics. They must also take in Vienna a part of the examination in anatomy, histology and physiology.

The Bureau of Standards reports that the supposed necessity for using large prisms and telescopes of large diameter when making accurate measurements on the index of refraction of optical glass has been investigated recently in the optical instruments section at the Bureau of Standards, and it was found that a 60 degree prism with edges measuring three eighths of an inch in length is sufficiently large for use with the most accurate apparatus now available. This work required a determination of the accuracy which is possible in pointing a telescope at a suitable target and also of the way in which this accuracy may vary as larger telescope lenses are used. Another matter depending on prism size is the error made in properly orienting the prism around a vertical axis when measuring its refractive properties. This difficulty is shown to be less important than has been generally supposed, and a satisfactory method of correcting for such small errors is suggested. It is concluded that large telescopes and special methods for correctly orienting the prism are unnecessary in the most accurate measurements of this kind. As a result, small prisms may be used with confidence when testing optical glass for those small but harmful variations in optical density which may be found within a sample intended for use in constructing an optical instrument of high precision.

The Oxford University Exploration Club, in its annual report for 1929–30, as summarized in the London *Times*, states that the launching of the club in December, 1927, was due to the energy of two or three men who had a definite objective: they wished to organize an expedition to Greenland, which, through the active aid of various senior Oxford men, was carried through to a successful conclusion. Thus the club had an effective start, which has been followed up by further expeditions to British Guiana in 1929 and to Lapland in 1930. The undergraduate membership has increased to 26, most of whom are both willing and eager to work on an expedition. It is hoped that a continuous succession of undergraduate organizers will be maintained, in order that this enthusiasm may be directed towards definite objectives. At the same time there are a number of members every year who are unavoidably prevented by

schools or other difficulties from taking part in expeditions; also the possibilities of expeditions leaving England except in long vacation have so far been considered negligible. With this in view a group of members began in March to organize a hut scheme, in collaboration with the Oxford University Mountaineering Club; their object is to secure huts and bothies in various out-of-the-way places in the mountain groups and Great Britain and Ireland, which will serve as bases for walking and climbing. The first of these huts, under Craig-yr-ysfa, in Cwm Eigiau, has now been put into working order. With the annual report is given an account of the British Guiana expedition in 1929. The aim, it is stated, was not primarily to explore unknown territory, but to penetrate into the canopy of the tropical rain-forest, which offered the prospect of discovering a zone of life practically untouched by science. Publication of results has already begun, but will not be complete for some years, owing to the large number of species involved and the little that is known about them. It seems certain that more new species have been secured than by any previous Oxford expedition. The contributions to the general ecology of the rain-forest, to knowledge of territory and related problems in bird-life, to insect mimicry, to life-histories of wasps and bees, and to the elucidation of the still obscure dominant species of trees are likely to be especially notable.

DISCUSSION

METEOR CRATER IS NOT A LIMESTONE SINK

IN SCIENCE, January 9, 1931, Mr. F. S. Dellenbaugh suggests that the great pit of Meteor Butte, in Arizona, is a sink formed by ground water solution in the Kaibab limestone. If this suggestion were addressed to geologists only, there would be no need for a reply. The geologic facts speak for themselves; they are not merely unfavorable to Mr. Dellenbaugh's idea—they disprove it conclusively. Inasmuch as his article reached an audience made up in large part of non-geologists, a brief statement of the geologic evidence is in order.

Mr. Dellenbaugh is correct in saying that the Kaibab limestone contains many sinks, which receive much of the surface drainage on the Kaibab Plateau. These sinks, however, and especially those of large size, are located on wide flats or on the floors of large shallow basins, where they receive considerable run-off. Solution of limestone is a slow process, and its accomplishment on a large scale requires a large quantity of water. It would be a wonder indeed to find in a semiarid country a sink, almost circular in plan and nearly a mile in diameter, occupying the entire top of a hill, where the only water available for solution consists of the scanty rain that falls directly on the area of the pit. For Meteor Butte is a hill, as its name implies. On all sides the ground slopes away from the very edge of the circular rim, and hence no outside drainage can enter the central depression. From this general consideration alone a geologist would be very skeptical of the sink hypothesis for this feature. The following points are sufficient to remove the hypothesis from further consideration.

(1) A limestone sink does not reach deeper than the base of the soluble formation in which it is formed. This is a fact of observation, and is also an elementary deduction, since the material that once occupied the position of the sink had to be removed by solution. At Meteor Butte, however, the Kaibab limestone forms less than half the height of the walls. Beneath it is the Coconino sandstone, one of the most insoluble rock formations known, since it consists entirely of quartz grains cemented by silica. Any suggestion that this sandstone may have caved in owing to solution directly beneath it is ruled out, because the Coconino sandstone rests on red shales and sandstones many hundreds of feet in thickness.

(2) At the top of the great pit the slopes on all sides are littered with fragments of the Coconino sandstone. These fragments range in size from minute bits of broken sand grains to blocks of large size; and they are intimately mixed with similar débris derived from the Kaibab limestone. How were these pieces brought up from their normal position hundreds of feet below? Obviously by a great force that acted upward and was explosive in character, since it not only hurled the angular blocks in all directions but even smashed the individual sand grains to tiny bits. Examination of this pulverized quartz leads to the conviction that much more of the rock blown out to create the crater was blasted into dust, which mounted in a great cloud and drifted away to settle as a thin veneer on the wide surface of the plateau.

(3) Although the rock strata are practically horizontal beneath a wide surrounding area, in the walls of the crater these strata are tilted and otherwise disturbed. On the south side, where the wall is steepest, the beds dip directly into the wall, at a high angle. There is no haphazard arrangement, such as would be expected if the disturbance were due to slumping into a solution pit. The tilt is consistent in direction, and indicates that a powerful lifting force acted inside the pit, with concentrated action on the south side.

(4) In places the quartz sand in the Coconino sandstone forming the lower part of the walls has been fused to glass (lechatelierite). This is astonishing in view of the extremely high melting point of quartz (nearly 1500° Centigrade). Evidently the crater has been subjected to intense heat, such as could be generated only in some exceptional way. (See A. F. Rogers, "A Unique Occurrence of Lechatelierite or Silica Glass," *Am. Jour. Sci.*, vol. 19, 1930, pp. 195–202).

In brief, all the evidence indicates that a violent explosion played a prominent part in the formation of the crater. The weight of this evidence was appreciated by the earliest investigators, and naturally the idea of a gaseous volcanic eruption was given serious consideration. The abundance of meteoritic iron on and around the butte, however, has given strong support to the theory that the great pit was caused by impact of a close swarm of meteorites, and by an explosion after the swarm penetrated to considerable depth. Owing to the strength of this theory the butte acquired its present name.

Mr. Dellenbaugh sees support for his own hypothesis in the fact that both the inside and outside slopes of the crater show the effects of erosion. Whatever its origin, the crater has been outdoors since its formation, and modification of its slopes by erosion has been inevitable. This fate it shares with every other landscape feature.

Finally, Mr. Dellenbaugh "sees nothing . . . that substantiates in the slightest degree the meteor theory." If he has in mind the particular hypothesis that called forth his discussion—Professor Fairchild's suggestion of a stony meteorite—I quite agree with his view. Although Fairchild's idea has interest to a geologist, it appears to be wholly speculative, and creates difficulties more serious than those it purports to remove. There is strong observational evidence, however, in favor of the theory involving metallic meteorites. Some of this evidence is discussed by Mr. D. M. Barringer in SCIENCE for January 16, 1931. An excellent non-technical review of the facts about Meteor Butte, accompanied by fine illustrations, has been published by William D. Boutwell ("The Mysterious Tomb of a Giant Meteorite"; *National Geographic Magazine*, Vol. 53, 1928, pp. 720–730).

CHESTER R. LONGWELL

YALE UNIVERSITY

BRANCHINECTA AT LEADVILLE, COLORADO

DURING the summers of 1929 and 1930, while engaged under the auspices of the United States Geological Survey in areal mapping and mine studies in Colorado, the writer found the phyllopod crustacean *Branchinecta coloradensis* (Packard) at 11,450 feet (3,500 meters) near Leadville, Colorado. The species has generally been regarded as alpine, and collections have been made nearby at Twin Lakes and Weston Pass in similarly elevated regions.[1] The occurrence is not surprising, but it raises again two perplexing questions.

In the upper part of Evans Amphitheater, due east about five miles from Leadville, are two larger lakes now serving as water reservoirs. Here is a well-developed recessional "kettle" moraine of late (?) Wisconsin glaciation. On the south side of the gulch near the reservoirs the moraine contains two small ponds, neither over 10 feet deep and both less than 100 feet wide. Both ponds, but the upper especially, are well separated from nearby water bodies. Indeed, it would require a valley flooding of at least a quarter of a square mile to a depth of 50 feet to connect the more isolated pool with a stream or with the reservoirs mentioned. Both pools are permanent, lasting throughout the short summer, but both are probably completely frozen during the winters at their elevation of 11,450 feet.

In these two pools the writer has found *B. coloradensis* during the past two summers. On July 18, 1929, *Branchinecta*, the females with brood pouches and eggs, were collected from the more easterly and isolated pond; by September 1, no live specimens were found, though a few remains of carapaces could be seen in the sediment. Again early in July, 1930, many *Branchinecta* were seen, the females again with eggs, this time in both pools; yet only a very few were in evidence by September 1. These observations are in general agreement with those of Shantz[2] near Pike's Peak, of Packard at Gray's Peak,[3] and of the latter especially in the case of related forms farther east,[4] where the disappearance is even earlier and is clearly not the result of lowered temperature. Shantz has suggested that the death of *Branchinecta* is related to parasitic plant forms, but the explanation does certainly not account for the Leadville records. It would seem that activity ceases in these Alpine species about September 1, and it would be interesting to develop an adequate explanation.

The other question is the unusual matter of "seeding" isolated ponds with *B. coloradensis*, or, for that matter, with other members of the family. The remarkable continuity of these phyllopods in a given pool, despite seasonal vicissitudes, is readily ex-

[1] A. S. Packard, U. S. Geol. Survey Ann. Rept. (Hayden), XII, Part I, 339, 1883; H. L. Shantz, *Biol. Bull.*, IX, 249, 1905; G. S. Dodds, U. of Colo. Studies, XI, 272, 1914–15; G. S. Dodds, U. S. Nat. Mus. Proc., LIV, 66–77, 1919.

[2] *Op. cit.*, pp. 256–258.

[3] *Op. cit.*, p. 339.

[4] *Op. cit.*, p. 342.

plained, but how did they come to their present habitat? Are we to assume that they represent a strain whose isolation dates back to glaciation, say, 10,000 years? If so, here is live material for the geneticist. Certainly a detailed study of their life history is merited.

CHAS. H. BEHRE, JR.

NORTHWESTERN UNIVERSITY

HEARING WITHOUT COCHLEA?

"THUS, even deaf persons whose eardrums no longer function properly, *but whose nerve centers are intact,* can hear radio."

By the distressed mother of a deafened child my attention was called to the above quotation from an article by Dr. Gustav Eichhorn in *Radio-Craft,* January, 1930, p. 330. "Thus" there means by the use of a patented device being essentially a membrane with one metal surface and one dielectric surface, which is held with its dielectric side close to the head. A telephone current passes to the metallized side of the membrane as to one condenser plate and to the human body (at any point) as if the body were the other condenser plate. The mother wanted to give her child this aid in hearing. There are many mothers like her.

The same matter is also described by the same author in the German periodical *Funk,* July 12, 1929, and still earlier in Jahrbuch f. drahtlose T. u. T., January, 1929. Since the eardrum, mentioned by the author, is no essential part of the auditory organ, I corresponded with him in order to know why he mentioned as the *exclusive* condition that "the nerve centers be intact." He was kind enough to reply that he had no definite opinion. Such a frequency of muscle function (6,000 and more per second) acting on the cochlea seemed to me unbelievable, and I felt inclined, therefore, to assume that we had here indeed a case of direct stimulation of the auditory nerve, especially since the author speaks of auditory perception of modulated currents by "Gehörlose," that is, the absolutely deaf. Those who can hear their muscle contractions are of course not Gehörlose.

If the auditory nerve could be used directly for hearing, that is, without the necessity of a mechanical function of the cochlea, this would be of tremendous importance for all those deaf people whose cochlea might be destroyed, but whose auditory nerve might be essentially intact. Dr. Eichhorn's description seemed to hint in this direction when it said that the electrical contact had to be made "gegen das Ohr oder an anderen Partien des Kopfes in der Nähe des akustischen Gehörzentrums," that is, "on the head in the neighborhood of the auditory braincenter."

I could not induce the author to send me one of his patented membranous devices. So I decided to experiment as well as I could. I used as source partly an oscillating electric system furnishing frequencies continuously between 50 and 20,000; partly amplified pick-ups of constant pitch phonograph tones of various frequencies. I removed the loud speaker, took one of the metal wires firmly in one hand, grasped the other wire end by its insulation and with its metal touched myself within the auditory meatus or behind the auricle; and to my astonishment in either case I heard faintly but clearly the very tone a moment ago produced acoustically by the loud speaker. After some experimentation I learned how to train others, many others, to perform the experiment with equal success, so that all possibility of "mere imagination" was excluded. It seemed to be true, then, that a new era of hope for the deaf had arrived, that the auditory nerve could be directly stimulated electrically and in agreement with the electrical frequency.

But after still more prolonged experimentation I now reject that hopeful conclusion. I shall mention three reasons why we must conclude that the hearing in question is due neither to direct action on the nerve nor to muscle contractions, but simply to a vibration of the horny skin surface caused by its electrostatic charge.

First, one does not hear anything when one touches the head with the wire end firmly. That is, there must be no electric conduction between the metal and the head. Nevertheless the metal must be held *close* to the skin for the sake of the electrostatic effect. This condition is realized by *gently rubbing* the wire over the skin, because then there is no real electric contact. As soon as one ceases to move the wire over the skin, the tone is gone, although that condition ought to be best for stimulating the nerve. I first thought that one might have to distinguish between an electrostatic and an electrokinetic stimulation of the nerve. But what would be the real difference?

Second, one hears more often the higher octave (that is, double frequency) than the actual cycle frequency. This is exactly what one should expect if the skin, statically charged by the neighboring wire end, is attracted and repulsed by the charge of the latter. A slight stretching of the skin is naturally advantageous.

Third, I succeeded in hearing the same tone when I rubbed the wire end gently over the slightly stretched skin of my wrist, holding the latter near enough, but not touching, one of my ears, nor touching any point of my head. The circuit then goes from one hand to the other hand by way of shoulder to shoulder. But there is no auditory nerve center

between the shoulders. Should one for an explanation fall back upon the distributed capacity of the whole body of which the nerve center is of course a part? This explanation is unlikely.

Thus the curious phenomenon of listening to the telephone wires without the telephone receiver resolves itself into nothing but a method of using the slightly stretched horny skin as an unusual kind of telephone receiver, an electrostatic receiver, a condenser receiver. One condenser plate is the skin, the other the wire end or still better wire loop; and the two acoustically vibrate toward each other. The cochlea still seems to be requisite for hearing. It's a pity so far as hope for the deaf is in question.

MAX F. MEYER
UNIVERSITY OF MISSOURI

COCCIDIOIDAL GRANULOMA

COCCIDIOIDAL granuloma is a disease of man and beast caused by Coccidioides immitis (Oidium coccidioides). The lesions may be in the skin, lungs and bones, and consist of granulomas and cold abscesses. The skin lesions are characterized by nodules and papulo-pustular eruptions. At times the lesion may resemble cutaneous tuberculosis; at other times syphilis or blastomycosis. The diagnosis is made by demonstration of the double contoured, endosporulating cells in the pus from the lesion, or in the stained sections of the tissue excised for this purpose. This should be further confirmed by cultural methods and by guinea-pig inoculation.

Cummins, Smith and Halliday,[1] in an epidemiologic survey of coccidioidal disease, collected 182 cases, the majority of which originated in California. East of the Mississippi River one case was collected from each of the following states: Illinois, South Carolina and Pennsylvania.

Recently the writer found this malady in a Negro, aged 36, a plasterer, with lesions on the right forearm and the right anal fold. This case originated, probably, in Tennessee.

It is probable that coccidioidal granuloma is widespread in this country.

FREDERICK W. SHAW
MEDICAL COLLEGE OF VIRGINIA,
RICHMOND

QUOTATIONS

BRITISH OPTICAL INSTRUMENTS

AN encouraging account of progress in the British optical instrument industry during the last five years is given in a memorandum prepared by the council of the British Optical Instrument Manufacturers' Association.

In the essential quality of transparency, British optical glass has always been superior to any made abroad. This superiority, it is stated, has been further increased in the last few years. Between 1885 and 1914 great advances were made in Germany in the production of glasses with new optical qualities, but the British remained superior in the manufacture of the finest quality of glass in large-sized disks, which present the greatest difficulty in manufacture. The Germans were pre-eminent only in the mass production of the smaller sizes, and in a larger range of kinds of glass. By 1928 the British manufacturers had extended their range of glasses, and in consequence of further advances since every durable and trustworthy kind of glass can now be obtained here. At the same time the ability to produce the very largest disks has been retained and even increased. Before the war the supply of spectacle lenses throughout the British Empire markets had very largely fallen into American hands. In recording gratifying advances in this field, the memorandum notes that of one particular make of spectacles developed and patented in this country 80 per cent. of the total production goes to the United States.

The memorandum states that the majority of cinema films, even in the United States, are made with lenses of British design made in Great Britain, and are also projected on the screen through British lenses. A range of instruments invented, patented, and made in this country was installed some years ago at the National Physical Laboratory for the testing of every kind of optical instrument, making it possible to state the results in numerical terms. Such tests, the memorandum points out, have established the superiority of the best British photographic lenses over the best made anywhere else. Part of this superiority is attributed to the new apparatus for testing. The two foremost manufacturers of photographic lenses in the United States and Germany, respectively, have recently purchased from the British inventor the right of using these test methods. Of prism binoculars it is reported that two of the highest class have been put on the market by a British manufacturer.

In the class of special surveying instruments, such as those used in the erection and maintenance of bridges, an instrument designed and made in Great Britain received, three years ago, the first prize offered by the German State Railways in a competition for

[1] W. T. Cummins, J. K. Smith, and C. H. Halliday, *Jour. Am. Med. Ass.*, 93: 1046, 1929.

such an instrument open to the world. British surveying instruments have been supplied in the last few years for use on the great Sydney, Zambesi, and Benue bridges, Takoradi Harbour, the Congo Boundary Commission, Egyptian dam construction, the 15-mile Lochaber water tunnel, and the preservation of St. Paul's Cathedral. Important developments of a few years ago in microscopes have been made accessible for the study of bacteria and other organisms, and of structures of the smallest sizes. The recent discoveries of the life history of the filter-passers have been chiefly accomplished in this country as a result of British improvements in instruments. Under the stimulus of Sir Robert Hadfield, a recent metallurgical microscope has been developed which, with other British inventions, has placed British metallurgists in a more favorable position than any of their rivals.

Strong as was the British position in 1925 in optical instruments for scientific research, which are the severest test of competence in manufacture and design, it is said to be even stronger to-day. Although some of the instruments which in 1926 were made only here are now made abroad, it is asserted that in quality no other country can equal them; and other instruments developed more recently in Great Britain are not made anywhere else. Britain is also the only country in which X-ray spectrographs are made by an optical firm of reputation. There is a British firm which makes four distinct types. In this achievement it has been directly helped by the remarkable work of Professor Laby, of Melbourne University, in the analysis of minerals by means of X-ray spectrographs, and the work done by the school of Sir William Bragg and Professor W. L. Bragg.—*The London Times.*

SCIENTIFIC BOOKS

The Life, Letters and Labours of Francis Galton. By KARL PEARSON, Galton Professor, University of London. Vol. III^{A} Correlation, Personal Identification and Eugenics. Pp. xii + 438. Frontispiece, extra plate; tail piece, 42 plates, and two loose charts. Vol. III^{B} Characterisation, especially by Letters, Index. Pp. 4 unnumbered + 232 numbered 441–672. 17 plates. Cambridge (University Press), 1930. 69 shillings for the two volumes.

NEARLY six years ago the first two volumes of this great biography were reviewed in SCIENCE (61: 209). Now, sixteen years after the appearance of the first volume, the work is complete. It will stand for all time as a monument to both subject and author. No other man of science ever had such a biography to preserve his memory.

These two final volumes are really one, as is indicated in the numbering, and are only bound in two for convenience in handling. The same infinity of painstaking care over the details of the production, illustration and documentation that marked the first two volumes is apparent here. In spite of advancing years it is still a firm and sure hand that penned these volumes.

This last volume deals, in its later parts, with the portion of Galton's life which was known at first hand by many persons now living. Obviously this has both advantages and disadvantages for a biographer (and in a minor degree for his reviewers). In this case it has led to a result which will be welcomed by Professor Pearson's old students. It is that the particularly full account of the last decade of Galton's life carries along with itself a good deal of autobiography of its writer. Regarding this Pearson says (III^{A}: vii):

> One apology I must make if the reader feels that in the chapter on the last decade of Galton's life the biographer has introduced too much of himself. To me that last decade was essentially bound up with our joint work for a subject we both had closely at heart; and I believe that for Galton himself our common aim—the establishment of Eugenics as an accepted branch of science—was a leading, if not the principal, purpose of those years. My own enthusiasm may possibly have deceived me, but I believed that Galton during that decade lived more in the struggles and difficulties of our infant Laboratory than in any other phase of his wide interests. The sympathy and help he always so readily tendered to his friends may again have misled me, but I think the history of the Laboratory he founded and finally endowed was also the essential history of his own life in those last years. At any rate such is the aspect of Galton's many-sided nature that I then saw most closely, and it is accordingly that which I am best fitted to render account of. To me his final crusade for eugenic principles was the crowning phase of a life whose labours in medicine, evolution, anthropology, psychology, heredity and statistics directly fitted him to be the teacher and prophet of the new faith.

There are three chapters in Volume III^{A}. The first of these deals with correlation and the application of statistics to the problems of heredity. Galton's first experiments on heredity began in 1875 with plants. He first attempted to get the relation between the weight of mother and daughter seeds of some plant like cress. Meeting with no success he turned to sweet pea seeds in the same year. From data in a notebook

of the time Pearson reproduces the first regression ever calculated, that between the diameters of parent and offspring peas. He comments as follows (p. 3):

> It is strange that both Galton and Mendel should have started from peas, the former from sweet and the latter from edible peas. Galton tells us distinctly why he chose the former, namely because he would not be troubled to the same extent by variation in size of peas within the same pod. We must leave it to the future to judge whether the correlational calculus, which has sprung from Galton's peas, is or is not likely to be of equal service with the vast system of factorial genetics which has arisen from Mendel's peas—and this even in the theory of heredity. We see now what Galton might have done, he might have provided us with data to check Johansen's later bean-weight experiments, he might have thrown light on the "pure line." He might possibly have reached the correlation coefficient instead of the regression slope in his first attempt to get a measure of correlation. Whatever he might have done, he reached the idea of regression before he reached that of the coefficient of correlation. As long as he was dealing with heredity in the same sex, the approximate equality of variabilities in the two generations preserved him from any great error.

Following the plan used in Vol. II, Pearson proceeds in this first chapter to analyze, digest and criticize Galton's biometric contributions to the problems of genetics. His ideas on correlation and heredity culminated in "Natural Inheritance," published in 1889, when he was 67 years old. Pearson says that this book created Galton's school, and started Weldon, Edgeworth and himself off on the study of correlation.

Galton believed that evolution proceeded chiefly by discontinuous steps, through the occurrence and preservation of what we now call mutations, and he called "sports." He believed that while what he called "variations proper" were inherited, they were of no importance in evolution because of "the constant tendency to regress." Pearson points out that Galton's methodology had led him astray here. He says (p. 83):

> In other words there is no "unexpected law of universal regression." Regression in Galton's sense arises solely from the fact that by clubbing into a single array the offspring of all fathers of a given character deviation he has given them not only mothers whose average stature will be mediocre, but also a mediocre ancestry. . . . Shortly, there is no law of "universal regression," and we can deduce from Galton's own theory that his "variations proper," if selected and inbred, would establish a breed with a "new center of regression." It is of course more than probable that our new center of regression, *i.e.*, the type of our new breed, may be unsuited to survive, that is to say in Galton's sense may be unstable. One can not alter one character in an organism without modifying all the correlated characters, and some of these altered are likely to have survival value. But Galton's own data and Galton's own theory rightly interpreted lead to no "universal regression," still less to an argument that "variations proper" can not be the subject of selection and the formation of new breeds.
>
> This does not prove that "variations proper" have been the basis of evolution, but it removes Galton's chief reason for belief in evolution by discontinuity, that is by sports or mutations. The law of "universal regression" —over which Galton undoubtedly stumbled—is only true when we neglect ancestry beyond the parents and suppose mating at random, but these are not the conditions which exist when intense selection is taking place and the selected interbreed.

There is much meat in this first chapter for the biometrician, and also some highly amusing bits, like the "average flush of excitement," and the problem of how to cut a round tea cake, the consumption of which was to extend over three consecutive days, in such manner as to leave a minimum of exposed surface to dry. Galton solved the problem; Pearson is suspicious that Galton and his niece did not eat all the cake according to the solution, because on the third day roughly four sevenths of the residue to be eaten was dry rind. A mere American's experience with English tea cake, extending at odd intervals over more years than he likes to think of, leads him to the view that the whole problem was supererogatory. No known English tea cake ever had sufficient moisture at any stage of its evolution or degustation to make the manner of its cutting of the slightest importance!

The end of the chapter recounts, with much reserve, the story of the Royal Society's "Committee for the Measurement of Plants and Animals." The committee was appointed at Galton's suggestion in 1894. The members were Galton (chairman), Francis Darwin, Macalister, Meldola, Poulton and Weldon (secretary). In 1896 Pearson was added. This group wanted to measure plants and animals; in short to do biometry. But from the start they were pestered by a group of unbelievers, led by Bateson. In 1897 some nine new members, zoologists and breeders, were added, including Bateson. The committee was renamed, "Evolution (Plants and Animals) Committee of the Royal Society." By 1900 Pearson and Weldon had resigned, and later Galton dropped out. The victory, for the other side, was complete. The Reports of the Evolution Committee became the vehicles of publication for the major part of Bateson's early Mendelian experiments.

The second chapter deals with Galton's finger-print work. Finger prints were a major interest and occupied much of his time between 1887 and 1895. Pear-

son gives first an account of the history of the use of finger prints for personal identification and its official adoption in England. Following this comes the story of Galton's attempts to popularize the method, and finally there is a résumé of his scientific contributions to the subject. This chapter is very fine. It lays down and documents a record which will make it forever impossible to take from Galton's memory the credit for building the foundation upon which all subsequent work on finger prints has been based, and particularly that part of it involving the official use of finger prints in criminal identification. The history of the matter is interesting. In the popular mind there is a wide-spread tendency to think of Bertillon as the originator of the use of finger prints for identification. As a matter of fact Galton introduced Bertillon to the method, as the latter himself acknowledged in a letter written in 1891. Actually the first *use* of finger prints for administrative purposes had been by Sir William Herschel in India as early as 1858. The merits of the claims of a Dr. Faulds to have been the pioneer in the field, put forward in definitive form in 1905, belittling the work of Herschel and Galton, are dealt with by Pearson as they deserve to be. The chapter ends with the following words (p. 215):

> The reader who has had the courage to follow Galton's biographer through the intricacies of this chapter will, I am sure, be convinced not only of the labor Galton devoted to his finger-print studies but also of the amazing energy he exhibited in acquainting not only administrative bodies but the public at large with the possibilities which then lay hidden in finger-printing, and this not solely for scientific but also for practical purposes. If the reader can find anyone who before 1895 had published a tithe of what Galton had issued on this topic, then I will admit him also to be a pioneer; if he can find anyone who has since 1895 done more than amplify in minor, often in very minor points Galton's work, then I will admit him a worthy successor to Galton.
>
> Finger-printing as a science and finger-printing as an art are both alike the product of Galton's insight, ingenuity and tireless activity; the attempts to belittle the credit due to him can only spring from those who for their own purposes choose to ignore the literature of the subject.

The third and last chapter, the longest in the whole work, is entitled "Eugenics as a Creed and the last Decade of Galton's Life." It will form the prime source authority for future students of the eugenics movement which flourished in the first half of the twentieth century. Galton started it. Pearson has lived through the flow of the tide. To this chapter all future workers will turn, who may be curious to know what happened. Furthermore, to those now living who are interested in and at all acquainted with the politics of science in England since 1900, this chapter will furnish mildly spiced reading. The battle royal between the Bateson and the Pearson schools, in which, as usual, neither side got all the spoils, but each got some, is handled with extreme discretion, but still with a sufficiently forthright clarity.

As a piece of historical writing this chapter is of great value. But one is reminded of a remark which has been attributed—I believe correctly, though I have not succeeded in running down the exact *locus* of the quotation—to one of England's greatest sons. It is this: "Science commits suicide when it adopts a creed." The story of the last ten years of Galton's life emphasizes the fact that these eight words quoted contain much wisdom. "Eugenics as a creed" makes its appeal to crusaders. Its idols tend to be either those of the forum or those of the cathedral. The record plainly shows that Galton became successively annoyed, harassed and finally appalled by some of the consequences of the thing he had started. Towards the end of his life he withdrew himself just as completely as possible from any connection with organized eugenics, with the exception of the Eugenics Laboratory under Pearson's direction. If these four great volumes before us demonstrate anything about Galton it is that he was enormously more a pioneer than a crusader.

The time has not yet come when an entirely realistic discussion of the origin and development of the eugenics movement will be possible. It is much too near us. Galton, in 1907, gave the money necessary to start the Eugenics Laboratory at University College. Later, in a codicil to his will, he permanently endowed it. That laboratory has made contributions of great value to the science of human genetics, under the guidance of Professor Pearson. This is what Galton primarily wished to accomplish by his gift. In his forty-second year he said: "I shall treat of men and see what the theory of heredity of variation and the principle of natural selection mean when applied to man," and, as Pearson remarks, this treatment only ended with his life. A scant three months before his death he wrote of the work of Eugenics Laboratory: "I hold it to be thoroughly scientific and most valuable, and I rejoice that I was its founder."

Volume III^{B} includes one long chapter composed chiefly of letters, and a very detailed and thorough index of the whole work. The letters are, for the most part, family letters, and are delightful. The index is a model.

And so comes to an end a remarkable, indeed a unique, piece of biographical work, a fitting and adequate record of a great man.

RAYMOND PEARL

THE JOHNS HOPKINS UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

HINT FOR BETTER GEOLOGICAL PHOTOGRAPHS

For years the writer has been dissatisfied with the mediocre results of his numerous attempts to photograph sand dunes, clay banks and other light-colored features in which contrast was deficient. Recently, following a hint from Dr. John E. Wolff, of Pasadena, he tried the use of a dark violet ray-filter. The results were splendid. Details such as fine ripple-marks on sand dunes stood out sharp and clear. In photographs of gravel banks each small pebble was distinct. In general almost every near-by object was beautifully rendered, and this was especially true of the light-colored ones.

The utility of this ray-filter in photographing landscapes seems to be limited to the immediate foreground. Up to distances of about 100 feet it gives excellent results; at 1,000 feet it is of doubtful value; and at the distance of a mile there is serious loss of detail and contrast, as compared with ordinary photographs taken without a ray-filter.

Geologists who need photographs of road cuts, gravel banks, quarries, rock outcrops, and other features of that nature, as well as desert surfaces, sea beaches, and all sorts of sedimentary deposits, will probably find this simple device useful, as it will enable them to obtain photographs that will make excellent half-tone illustrations and will possess unusual clearness of detail. Since the length of exposure must ordinarily be multiplied by ten when the violet ray-filter is used, the latter will not ordinarily be practical for simple hand cameras without tripods, especially as it is generally necessary to use a small diaphragm aperture in order to secure depth of focus in the foreground.

ELIOT BLACKWELDER
STANFORD UNIVERSITY

A SIPHON MOIST CHAMBER

I HAVE just read an article by Florence A. McCormick in the January 30 number of SCIENCE, entitled "A Siphon Moist Chamber for Microscopic Mounts." A question has arisen in my mind concerning one statement that is made in this article: "A mount can be made in a nutritive solution and with this method the concentration will not be changed." Since there is a constant evaporation from the edges of the cover-glass and the solution is being added to from the wick, it seems to me that the concentration under the cover-glass will be increasing because of the loss of moisture from around the edge which in turn is replaced by a nutrient solution. This difficulty, however, could be overcome by using a nutrient solution in the first place and then replacing the water lost by evaporation by distilled water through the wick. I realize that there may be a tendency for some of the nutrient solution to pass back into the wick and thus dilute the concentration slightly, but it seems doubtful under the conditions as to whether this would be of any consequence and certainly would not be as great a factor as the concentration of the solution would be where a nutrient solution is used to replace the water lost by evaporation.

C. C. THOMAS

SPECIAL ARTICLES

A DIRECT QUANTITATIVE RELATIONSHIP BETWEEN VITAMIN A IN CORN AND THE NUMBER OF GENES FOR YELLOW PIGMENTATION

It has been known for some years that yellow corn is richer in vitamin A than white corn.[1] A similar association between vitamin A and carotinoid pigments has been discovered in many other materials; also there are numerous cases in which this association does not occur. Since the carotinoid pigments in the endosperm of corn are known to be inherited in definite Mendelian ratios, and since the technique for estimating the amount of vitamin A has been perfected to a degree of reasonable reliability, the writers have felt that estimations of vitamin A in seeds resulting from different doses of the gene for yellow pigment would throw additional light on the association of the carotinoid pigments with the nutritional factor and might also have some bearing on the behavior of the gene. Accordingly, work on this problem was undertaken in 1928. Steenbock and Boutwell[1] had already shown that, on ears segregating for white and yellow endosperm, the deep yellow seeds were higher in vitamin A than a mixture of the pale yellow and white seeds. After our work was started, a paper by Hauge and Trost[2] reported that the white seeds on segregating ears of a cross between yellow and white are no more effective in promoting growth than seeds of the white-seeded parent. Both these investigations indicate strongly an association of yellow pigment with vitamin A in inheritance but neither shows the quantitative relation of the nutritional factor to different doses of the gene involved. In fact, Hauge and Trost found the light yellow seeds, which were a mixture of two genotypes, to be apparently as effective in promoting growth as the deep yellow seeds.

The endosperm of corn, as of most of the angio-

[1] H. Steenbock and P. W. Boutwell, *J. Biol. Chem.*, 41: 81.

[2] S. M. Hauge and J. F. Trost, *J. Biol. Chem.*, 80: 107.

sperms, is the product of a sexual fusion in which two maternal nuclei combine with one pollen nucleus. Consequently, it is triploid in its chromosomal constitution. This has been repeatedly demonstrated, both cytologically and genetically. The triploid nature of the endosperm makes it possible to produce four classes of seed differing in the proportion of dominant and recessive genes. In the case of the factor for yellow pigmentation, the cells of the endosperm may have 0, 1, 2 or 3 genes for yellow pigment with the corresponding factorial composition *y y y*, *y y Y*, *y Y Y* or *Y Y Y*. These four classes differ in color and may be described roughly as white, pale yellow, dilute yellow and deep yellow. If all types occur on the same ears it is often difficult to make an accurate classification, especially between the two intermediate classes. By making appropriate pollinations, however, they can be separated with a high degree of accuracy.

In 1928 pollinations were made to produce these four classes of seeds. Surcropper, a white-seeded variety, and Ferguson's Yellow Dent, a yellow-seeded variety, were pollinated by a mixture of pollen from both sorts. On the ears of the white-seeded variety two types of seeds were produced, white and pale yellow, having, respectively, 0 and 1 factors for yellow endosperm. On the ears of the yellow seeded variety two additional types, dilute yellow and deep yellow, were produced, having, respectively, 2 and 3 factors for yellow endosperm.

The vitamin assay of these four classes was made by feeding to albino rats according to the Sherman-Munsell unit method.[3] The results in 1928 showed a high degree of association between the number of genes for yellow pigment and the number of units of vitamin A per gram of material. The pollinations and vitamin estimates were repeated in 1929 with corn grown under different seasonal conditions. Again, almost complete association was shown. The average results for two years are shown in the following table:

No. of genes for yellow	Factorial composition of endosperm	Units of vitamin A per gram		
		1928	1929	Average
0	*y y y*	0.05	0.05	0.05
1	*y y Y*	2.50	2.00	2.25
2	*y Y Y*	5.00	5.00	5.00
3	*Y Y Y*	7.00	8.00	7.50

These results show, first, that a white-seeded variety of corn, which ordinarily has little or no vitamin A in the endosperm, is capable of forming this substance in its seeds if the gene for yellow pigmentation is introduced. The white and pale yellow seeds were produced by the same plants, the only difference between them being in the microscopic pollen nuclei which entered into the fusion to produce the endosperm.

The next point of interest is that there is a direct quantitative relationship between the number of genes for pigmentation in the cells of the endosperm and the amount of vitamin A in the seed. Each gene for yellow induces the formation of approximately 2.5 units of vitamin A per gram of seed. The obvious conclusion must be that the gene for yellow pigmentation is responsible for the formation of vitamin A, either directly, or indirectly, with the production of carotinoid pigments as an intermediate step.

Finally, these results may have some bearing on the chemical nature of this particular gene. So far as we are aware, this is the first case in which it has been possible to establish, with any degree of exactness, a direct quantitative relationship between different doses of the same gene and their chemical effect. Although even this tells us little of what the gene may be, it does, perhaps, furnish some indirect evidence of what the gene is not. It seems scarcely probable, for example, that this gene functions as an enzyme, since the total reaction resulting from enzyme activity is seldom closely related to the concentration of the enzyme, while each gene for yellow pigment seems to govern the formation of a definite quantity of vitamin A. It is true that the rate of a reaction in which an enzyme is involved varies with the concentration of the enzyme, but the proportion is usually not a direct one like that shown here.

The straight-line relationship between the number of genes for yellow pigmentation and amounts of vitamin A is more indicative of a direct chemical reaction between the gene and some other substance which is present in the cells of the endosperm of both white-seeded and yellow-seeded varieties of corn.

P. C. MANGELSDORF
G. S. FRAPS
TEXAS AGRICULTURAL EXPERIMENT STATION

[3] H. C. Sherman and H. E. Munsell, *J. Am. Chem. Soc.*, 47: 1639.

A DIFFERENTIATION OF THE SO-CALLED ANTIPELLAGRIC FACTOR, VITAMIN G[1]

IN February of 1926 Goldberger and coworkers[2] and Smith and Hendrick[3] have demonstrated the dual nature of vitamin B. In May of the same year Goldberger and Lillie[4] submitted evidence that a deficiency of the stable factor in a diet fortified with an abun-

[1] Research Paper No. 142, Journal Series, University of Arkansas.

[2] Goldberger, Wheeler, Lillie and Rogers, Pub. Health Rep., 1926, 41: 297–318.

[3] Smith and Hendrick, *ibid.*, 1926, 41: 201–207.

[4] Goldberger and Lillie, *ibid.*, 1926, 41: 1025–1030.

dance of the labile, antineuritic substance resulted in a pellagra-like disease in the rat. Following the arrest of growth, alopecia and bilateral symmetrical lesions of the skin were the most noteworthy symptoms noted. Although the work of Goldberger and associates has in the main been substantiated in this country and England, Salmon, Hays and Guerrant,[5] and Chick and Roscoe[6] have suggested the complicity of the antipellagric dietary essential, since occasionally animals deprived of this syndrome remain stunted in growth but exhibit no skin lesions.

During the past two years, while engaged in studies of the biochemistry and pathology[7] of the pellagra-like avitaminosis in the albino rat, we have had occasion to observe various manifestations of the so-called vitamin G deficiency in 125 animals. The disease was produced by one of us (B. S.) on a dietary régime described elsewhere.[8] The optimum ration for the production of the dermatitis was found to be one deficient in the vitamin B complex, supplemented by a daily allowance of 500 mg of rice polishings, irradiated for 10 hours, according to the suggestion of Hogan and Hunter,[9] in order to insure the destruction of the greater portion of vitamin G. To summarize our results of 1929, the majority of the animals in which pellagra-like symptoms were produced showed dermatitis 20 to 50 days preceding the cessation of growth. On the other hand, our experience with other vitamin G deficient diets has been that the majority of animals failed in growth markedly without any accompanying skin lesions; and we would like to point out in this connection that all our rations were amply fortified with the antineuritic, growth-promoting factor. We have repeated our experiments of 1929 and have corroborated our former findings that there is no relation between failure in growth and the incidence of pellagra-like symptoms in the rat, the dermatitis being prevalent in some animals that make normal growth and absent in others that are first stunted in growth for weeks and months, and that finally collapse following great losses of weight. Recently we found accentuated dermatitis in six positive controls, out of 12 studied, accompanying excellent growth, the males having attained a weight of 240 to 270 grams and the females a weight of about 200 grams. The rations of the positive controls contained 10 per cent. autoclaved yeast as a source of vitamin G, and irradiated rice polishings as a source of vitamin B. Since we autoclave our yeast (Northwestern) at 20 pounds pressure for 6 hours, it is quite possible that, under our conditions, we are destroying the greater portion of the antidermatitis factor, at the same time not injuring the relatively stable growth-promoting factor. We, therefore, conclude that the so-called vitamin G is composed of two dietary essentials: one the deficiency of which produces pellagra-like symptoms in the rat; and another the deficiency of which produces a decline of growth.

Since the nomenclature of the so-called antipellagric factor is still in a state of confusion, the English investigators calling it vitamin B_2, while the American biochemists refer to it as vitamin G, the letter F of the vitamin alphabet having been left unrepresented,[10] we suggest a logical home for the letter F and have it indicate the stable growth-promoting factor associated with the vitamin B complex, and that we retain the letter G for the antipellagric factor, the deficiency of which produces the characteristic skin lesions in the rat.

BARNETT SURE
MARGARET ELIZABETH SMITH
M. C. KIK
DEPARTMENTS OF AGRICULTURAL CHEMISTRY AND HOME ECONOMICS,
UNIVERSITY OF ARKANSAS

[5] Salmon, Hays and Guerrant, *J. Inf. Dis.*, 1928, 43: 426–441.

[6] Chick and Roscoe, *Biochem. J.*, 1927, 21: 698.

[7] Thatcher and Sure, Arch. of Path., in press.

[8] Thatcher, Sure and Walker, *So. Med. J.*, 1930, 23: 148.

[9] Hogan and Hunter, *J. Biol. Chem.*, 1928, 78: 433–445.

[10] Report of Committee on Nomenclature of American Society of Biological Chemists, SCIENCE, 1929, 69: 276.

LIVER EXTRACT AS A SOURCE OF VITAMINS B AND G[1]

SOME of the early investigations of the distribution of vitamins showed that the livers of animals were a good source of vitamin B (vitamin B + G). More recently liver and liver extracts have been widely used in the treatment of pernicious anemia.

Curtis and Newburgh[2] last year reported some feeding tests with liver extract. They found that when 2 per cent. of liver extract (Lilly) was added to a basic diet containing no other source of vitamin B, growth and energy ingestion were approximately normal; the replacement of liver extract by equal amounts of yeast vitamin powder (Harris) caused less growth and less energy ingestion. If the liver extract was autoclaved before feeding, all the experimental animals developed polyneuritis. These tests indicated that liver extract was a good source of both vitamins B and G but gave no information regarding the relative richness of the substance in the separate factors.

[1] Read before the Biological Section, Alabama Academy of Science, Auburn, Alabama, April 18, 1930.

[2] A. C. Curtis and L. H. Newburgh, "The Effect of Liver and Liver Extract upon Appetite," *Jour. Clin. Inv.*, 7: 518, 1929.

We were primarily interested in determining whether one of the commercial liver extracts[3] would offer a good source of vitamin G for further concentration of the active factor.

Experimental

Rats averaging 45 gms in weight were fed Diet 2B consisting of extracted casein 18, salts (No. 186) 3.7, agar 2, corn starch 69.3, butterfat 5, and cod-liver oil 2 parts for a preliminary depletion period of two weeks. The rats were fed in groups during this preliminary period; they were then placed in individual cages and given the test material, fed separately from the basal diet. Preliminary tests on 0.05 and 0.10 gm of liver extract per rat daily indicated that these dosages did not furnish a sufficiency of vitamins B and G for normal growth; on the 0.05 gm dosage there was rapid development of beriberi; even on 0.10 gm there was eventual development of beriberi. Later tests were conducted on daily dosages of 0.10 and 0.20 gm both with and without an added vitamin B supplement. The vitamin B supplement was prepared by adsorbing on fuller's earth the vitamin B from a concentrated alcoholic (80 per cent. alcohol by weight) extract of white corn.[4] Tests were simultaneously conducted upon a high-grade brewer's yeast for comparison. The average gain per rat during a period of nine weeks following the two weeks' preliminary period is shown below.

Average Gain Per Rat for Nine-week Experimental Period

	Gms
0.10 gm liver extract	3.0
0.20 gm liver extract	65.0
0.10 gm liver extract plus 0.05 gm vitamin B solid	172.0
0.20 gm liver extract plus 0.05 gm vitamin B solid	165.0
0.05 gm brewer's yeast	21.0
0.10 gm brewer's yeast	58.0
0.10 gm brewer's yeast plus 0.05 gm vitamin B solid	51.0
0.20 gm brewer's yeast plus 0.05 gm vitamin B solid	72.0
0.05 gm vitamin B solid	11.0

It is evident that the liver extract tested is an excellent source of vitamin G, 0.10 gm per day furnishing a sufficiency of this factor for normal growth of the rat through an experimental period of nine weeks. It is not such a good source of vitamin B; 0.10 gm per rat daily as the sole source of this factor produces some increase in weight for a few weeks but the initial increase is followed by a decline in weight and the onset of beriberi. The liver extract tested apparently contained four or five times as much vitamin G but only about one fifth as much vitamin B as the sample of brewer's yeast. The vitamin B content of the extract compared favorably with the vitamin B content of the pure dried baker's yeast which we commonly obtain on the market.

W. D. Salmon
N. B. Guerrant
Alabama Polytechnic Institute

[3] The extract (No. 343) was kindly furnished by Eli Lilly and Company.

[4] W. D. Salmon, N. B. Guerrant and I. M. Hays, "The Effect of Hydrogen Ion Concentration upon Adsorption of the Active Factors of Vitamin B Complex by Fullers' Earth," *Jour. Biol. Chem.*, 80: 91, 1928.

BOOKS RECEIVED

Abhandlungen der Medizinischen Fakultät der Sun Yatsen-Universität. I Band 2, 3 und 4 Heft. Pp. xi + 295. 114 figures. II Band 1 Heft. Pp. 126. Verlag der Sun Yatsen-Universität, Canton.

de Albenino, Nicolao. *Verdadera relacion delo sussedido enlos Reynos e prouincias del Peru desde la yda a ellos del Virey Blasco Nuñes Vela hasta el desbarato y muerte de Gonçalo Piçarro (Sevilla, 1549).* Institut d'Ethnologie, Paris. 45 fr.

Burton, William W. *Plane Trigonometry.* Pp. x + 125 + 93. 65 figures. Thomas Y. Crowell. $2.50.

Cole, Lawrence W. *Factors of Human Psychology.* Second edition, revised. Pp. 612. 42 figures. University of Colorado Press.

Fenneman, Nevin M. *Physiography of Western United States.* Pp. xiii + 534. 172 figures. McGraw-Hill. $5.00.

Flint, Richard F. *The Glacial Geology of Connecticut.* Bulletin No. 47. Pp. 294 + vii. 64 plates and 40 figures. Connecticut State Geological and Natural History Survey. $2.00.

Ginzburg, Benjamin. *The Adventure of Science.* Pp. xvi + 487. Simon and Schuster. $5.00.

Griaule, Marcel. *Le Livre de Recettes d'Un Dabtara Abyssin.* Pp. x + 160. 140 figures. Institut d'Ethnologie, Paris. 70 fr.

Holt, Edwin B. *Animal Drive and the Learning Process.* Volume I. Pp. vii + 307. Supplementary essay. This Material World, by Harold C. Brown. Holt. $2.50.

Jeans, Sir James. *The Universe Around Us.* Second edition, revised. Pp. x + 351. Illustrated. Macmillan. $4.50.

Lahee, Frederic H. *Field Geology.* Third edition. Pp. xxxi + 789. 538 figures. McGraw-Hill. $5.00.

Records of the South Australian Museum. Volume IV. No. 2. Pp. 145–273. Illustrated. Public Library, Museum and Art Gallery of South Australia, Adelaide, South Australia. 10s/6.

Schuchert, Charles. *Outlines of Historical Geology.* Second edition. Pp. v + 348. 157 figures. Wiley. $3.00.

Stern, Bernhard J. *Lewis Henry Morgan, Social Evolutionist.* Pp. ix + 221. University of Chicago Press. $2.50.

Thompson, Homer C. *Vegetable Crops.* Second edition. Pp. ix + 560. 59 figures. McGraw-Hill. $5.00.

Tôhoku Imperial University. Science Reports. First series: Mathematics, Physics and Chemistry. Volume XIX, No. 4: Pp. 365–472. 3 plates; No. 5: Pp. 473–680. 7 plates. Maruzen Company, Tokyo.

Weyl, Von Hermann. *Gruppentheorie und Quantenmechanik.* Pp. xi + 366. Verlag Von S. Hirzel, Leipzig.

SCIENCE

Vol. 73 | Friday, March 6, 1931 | No. 1888

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

MASS ACTION IN CEREBRAL FUNCTION[1]

By Professor K. S. LASHLEY

DEPARTMENT OF PSYCHOLOGY, UNIVERSITY OF CHICAGO

Introduction

In the field of neurophysiology no fact is more firmly established than the functional differentiation of various parts of the cerebral cortex. We are removed from Flourens by nearly 75 years of intensive anatomical research which has settled beyond question the histological diversity of the cortical fields and of their connections with subcortical nuclei. A wealth of physiological and clinical evidence accords with the anatomical findings and proves the association of at least the majority of the cortical fields with special functions. No one to-day can seriously believe that the different parts of the cerebral cortex all have the same functions or can entertain for a moment the proposition of Hermann that because the mind is a unit the brain must also act as a unit.

Yet the problems of localization and of cerebral physiology are far from solved by the demonstration of the anatomical diversity of the cortical fields and of consistent symptoms following the destruction of each. From the practical view of diagnosis there are still problems of the fineness of localization, of the types of functions which are localizable, of the significance of individual variations, and the so-called negative cases.

Symptoms involving purely sensory or motor defects have the most certain diagnostic value: a monoplegia or a limited zone of cutaneous anesthesia are surely indicative of a focal lesion whose position may sometimes be predicted within a few centimeters. But a defect of color vision, a disability in reading, an

[1] Lecture delivered before the Harvey Society, New York, November 20, 1930.

apraxia, or a syntactical aphasia are indicative only of disturbance somewhere within a rather widely extended field, while a simple defect of judgment or change in personality, even when of unquestionable organic origin, can not now be associated with any cerebral locus.

Except in a few instances, it is impossible to predict with any certainty from the locus or severity of a lesion what will be the course of recovery or of deterioration. Until we know more of the nature of depression, diaschisis and the factors of spontaneous recovery, until we know the limitations of reeducation and of vicarious functioning, therapeutic methods must be somewhat uncertain.

From the standpoint of an adequate cerebral physiology also, the classical concept of cerebral localization is of limited value, because of its static character and its failure to provide any answer to the question of how the specialized parts of the cortex interact to produce the integration evident in thought and behavior. The problem here is one of the dynamic relations of the diverse parts of the cortex, whether they be cells or cortical fields. The diversification of parts is a fact of fundamental importance, but it is only one of many which must be discovered before we can form any adequate conception of cerebral organization.

There is a very close relation between the problems of cerebral physiology and of psychology and each science must be broad enough to accommodate itself to the facts revealed by the other. We must agree with Henschen that *a priori* psychological analysis has contributed little to our understanding of cerebral function and has often confused the issues, especially in the study of the aphasias. On the other hand, simplified physiological theories of neural integration have hampered the development of psychology and have contributed to a futile sort of psychological atomism. Cerebral physiology and to a large extent the concepts of psychology must be built up from the empirical basis of anatomical and clinical facts, but we can not ignore the problems of integration which are presented by normal behavior. We must not forget, as many of the diagrammatists seem to have done, that cerebral areas somehow do perform the functions which are lost when they are destroyed, and that we must account not only for defects, but for normal activity as well.

Diverse Functions of the Visual Area

To-night I wish to report the results of our attempts to analyze the function of a single field of the cerebral cortex, the visual area. This, of all cortical fields, presents the most definite evidence for fine structural and functional differentiation and at the same time reveals activities which are among the most difficult to fit into any schema of localization. Our approach has been essentially that of Goltz, Munk, Luciani and Hitzig, but with the use of quantitative methods of studying behavior and of analyzing the anatomical findings which were not available to earlier workers.

The experimental work is largely limited to the rat. The advantages of this material are the simplicity of the animal's behavior, its steadiness in activity under the motivation of hunger and its availability in large numbers. The last has made possible the use of experimental and statistical controls which would have been impossible with any larger form.

The danger of generalization from the rat to man is obvious. Our program includes the use of this material only as a means of outlining problems and gaining clues which must in every case be retested by experiments with primates and by comparison with clinical evidence. So far as we have been able to carry out such controls, there has been a clear agreement between the results with the rat and with primates. Actually these lower animals seem to show the beginnings of every human mental trait and I have come to doubt that the evolution of mammals has introduced any change in the fundamental organization or mechanism of cerebral activity. The enormous differences are in degree rather than in kind.

Our present knowledge of the structure of the visual system in the rat is still imperfect. There is a definite visual area of the unistriate type occupying a position on the dorsal convexity of the occipital pole.[2] Volkmann[3] also distinguishes a smaller medial area as homologous with the visual association area of higher forms. From the retina there is a large crossed tract which terminates in the lateral geniculate body and in the superior colliculus. The small uncrossed bundle in Marchi preparations seems to terminate in the lateral geniculate body. From the thalamus a large tract ascends to the striate area. Its exact origin and termination have not been worked out. From the cortical area a large tract descends to the internal capsule, a second smaller tract passes to the callosum. Except for this commissural tract there are no long transcortical fibers from the area.

A word as to methods: for testing vision in animals we have used two types of apparatus. The more familiar type is the discrimination box in which two different visual stimuli are displayed at the ends of

[2] Fortuyn, *Arch. Neurol. and Psychiat.* (London), 6, 221, 1914.

[3] Anat. Anz., Erganzungsheft, 61, 234, 1926.

two adjacent passages, so as to be visible to the animal from the common entrance. The stimuli are alternated in position irregularly on the right or left in successive trials and the animal is trained to go to one of the stimuli for food, in whichever passage it may be displayed. The discrimination box has served for the study of thresholds for brightness but is unreliable for tests of detail vision. For the latter the method is modified so that the animal must jump from a distance against one of two cardboard doors bearing different visual patterns, one of which may be knocked aside to allow him to reach food. This method works rapidly for tests of pattern vision. For testing learning and memory, latch boxes or mazes through which the animal must learn the direct path are used. By these means we may study the limits of visual capacity, such as thresholds, acuity or ability to distinguish complex patterns or to identify pictures with objects, and also the rate at which visual and other associations are formed and the loss of visual and other memories as a result of brain injuries.

The neurological variables which may be studied quantitatively are the locus of lesion with respect to the cortical fields, the absolute extent of destruction, and the time interval between operation and tests. The destruction of cerebral tissue may precede training in tests of the influence of lesions upon the limits of capacity, or may follow in tests of postoperative amnesia. In all cases reported the lesions have been carefully reconstructed from measurements of serial sections.

Specificity of Function in Pattern Vision

The rat has a fairly good capacity for pattern vision.[4] He is very near-sighted, the far point being at about 8 cm. His acuity is about 1/60 that of man. With these limitations his vision does not seem essentially different from that of man. He can readily distinguish position, distance, brightness, relative size and complex outlines. If he learns to differentiate between two solid figures he recognizes immediately outlines of them differing in size, or even partial outlines. That is, essentially, he can recognize pictures of objects. He can learn to pick out a variable from a constant part of a complex pattern.

For test of cerebral localization we have made a general survey of the whole cortex, destroying parts, symmetrical on the two hemispheres, with knife or thermocautery.[5] With recovery from the operation the animals were put through a number of tests of vision, then brought to necropsy, and the lesions reconstructed from serial sections. Our tests have now covered about 50 cases with lesions in all parts of the cortex.

Fig. 1 shows the results of the experiments. Destruction of a small region in the lateral part of the visual area completely and permanently abolishes the capacity for detail vision. The animals still jump readily, distinguish the position and distance of single objects and can distinguish between two objects of different size or brightness, but they fail on every test which requires the discrimination of patterns. The defect in vision is no greater if the whole of the occipital cortex is destroyed. Vision for discrete objects, their relative position and brightness is retained after lesions including any part of the cortex.

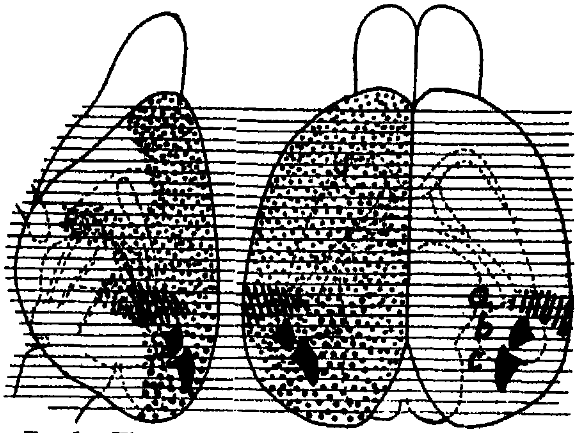


FIG. 1. Visual areas of the cerebral cortex of the rat. The stippled areas represent the regions destroyed by operations, symmetrical on the two hemispheres, without disturbance of the capacity for pattern vision. The coarser stippling indicates the position of the anatomical *area striata*. Destruction of the cortex at b or c on both hemispheres completely abolishes vision for patterns but leaves the capacity to distinguish the position and relative brightness of gross objects, as does the total destruction of the visual cortex. Interruption of the projection fibers at a abolishes all vision for objects but leaves the capacity to distinguish differences in the intensity of light.

We have here, then, a definite restriction of the function of pattern vision to one small area of the cortex. There is no interference with detail vision in our tests after destruction of any other part of the cortex. In all the tests the animals were normal in all visual tests after the destruction of the motor, or somesthetic, or auditory, or of the greater part of the visual area, including the supposed visual association area.

The localization of the visual field is as precise and as absolute as it is in man. Within the field there may be an accurate representation of different parts of the retina. We have no method for mapping

[4] Lashley, *Jour. Genet. Psychol.*, 37, 453, 1930.
[5] *Jour. Comp. Neurol.*, in press.

scotomata in the rat and hence can only infer finer specialization from data on higher animals. Since any other part of the cortex than the visual area can be destroyed without disturbance in our tests, it seems clear that the simple motor habits involved do not require the formation of any special transcortical associations with other fields, but are carried out merely by the coordinated activity of the visual cortex and the subcortical visual and motor nuclei. There are indications in the anatomical studies of Poljak and in the experimental work of Jacobsen and myself that this may be the condition in primates also.

If we destroy the optic radiations as they leave the internal capsule, we have a different picture. In all tests requiring jumping the animals behave exactly as do others deprived of their eyes. Yet they are not completely blind. In a simpler situation, the discrimination box, where they must run past the stimulus, they can still distinguish light from darkness and can form habits based upon this discrimination as readily as do normal animals.

All this seems clear enough and consistent with a thoroughgoing theory of localization. Pattern vision is a function of the visual cortex, the identification of the position of single objects is possible through the action of projection fibers to other than the anatomical visual area, and the discrimination of the intensity of lights may be wholly a function of the thalamus and midbrain.

Limited Specificity in Discrimination of Brightness

But when we study further the function of brightness vision, that is, the discrimination of light from darkness, in the discrimination box, a difficulty immediately arises for so simple an interpretation. In the absence of the entire visual cortex the habit of light-darkness discrimination is formed at normal rate. We have data now on 113 cases with injuries in the visual cortex and 89 normal controls. There is no significant difference in their rates of learning. But if we train normal animals and then subject them to operation in the visual area, they lose the habit. If the entire visual cortex is destroyed, the post-operative amnesia is complete. The animals can relearn to make the discrimination, but require just as much practice as they did for initial learning before operation. This loss can not be accounted for upon the grounds of cortical blindness, for the animals relearn at normal rate and are obviously not blind. It is not a simple sensory defect, for if it were, the defect should show in the initial learning of animals which lack the visual areas, and these are normal in the formation of this habit. We can only describe the loss as an amnesia, in contradistinction to sensory defect.

The next step in our analysis is to determine the effects of partial destruction of the visual area upon the habit based on brightness discrimination. If only a part of the visual cortex is destroyed, the animal shows amnesia but relearns more rapidly than when all is destroyed. It makes no difference what part of the visual area is involved, the effect is the same. In a series of cases the relationship between the extent of lesion and the degree of amnesia is very close, whereas the locus within the visual cortex is immaterial.[6]

These results can be interpreted, I believe, only by assuming that the visual cortex acts upon the lower visual nuclei in such a way as to facilitate their activities in the performance of functions which they nevertheless can carry out in the absence of the visual cortex. There is still localization, in the sense that the visual area and no other part of the cortex exerts this effect, but the effect is independent of that finer localization which is essential for pattern vision. For this function there are not subordinate localizations of functions within the visual cortex, but the area acts as a unit, each part providing energy or facilitation of the lower centers, as does each other part.

We have closely comparable data for the latch-box. This is learned at normal rate by animals lacking any half of the cortex, yet when it is learned by normal animals an amnesia follows the destruction of any part of the frontal region.

Turning now to another aspect of the visual problem: Testing for threshold of discrimination between different intensities of light we find that animals lacking the visual cortex have on the average a higher threshold than normals and that they are slower in learning to choose between lights whose difference is well above their threshold.[7] The disability here does not seem to be one of actual visual defect, so much as of instability of the visual reactions. The animals seem to fail the tests near threshold values, not so much through inability to discriminate as through inability to react consistently enough to reach the high standard of accuracy required as evidence of discrimination. One or two cases, entirely lacking the visual cortex, showed a threshold as low as normal, after long training.

In this case the visual cortex seems, speaking figuratively, to keep the subcortical visual centers on the job, possibly by a facilitation which maintains an increased responsiveness or increased excitability

[6] Lashley, *Jour. Comp. Neurol.*, 41, 1, 1926.
[7] Lashley, *Jour. Genet. Psychol.*, 37, 461, 1930.

without contributing to the specific integrations involved.

This sort of general facilitating action of one center upon another is not unfamiliar in neurological theory, since it forms the basis of Monakow's theory of diaschisis. Our results for the visual field depart from Monakow's theory first in that the functions lost from withdrawal of facilitation do not recover spontaneously, but may be reacquired by reeducation, second, in that the effect may be specific for integrations already formed in learning and need not involve the capacity to form those associations, and third, that the severity of diaschisis is proportional to the amount of tissue destroyed.

There are indications that similar conditions underlie many of the symptoms of brain lesions in higher animals and man. The cerebral paralyses give a picture which is the inverse of the preceding. We trained a group of rhesus monkeys to open puzzle boxes by turning a crank, opening a gate hasp, and the like.[8] Their retention of these problems was found to be perfect after three months. They were then subjected to operation involving removal of both precentral gyri. The resultant diplegia cleared up after three months to permit of fairly deft movements of the hands. During the recovery period the animals did not see the problem boxes. About four months after the operations their ability to open the boxes was tested. All solved the latches practically at once, without random activity, and used the same methods that they had employed before the destruction of the motor cortex.

In this case we seem to be dealing with two mechanisms which have somewhat the relations of the visual cortex and lateral geniculate bodies. Destruction of the motor cortex does not abolish the specific integrations involved in the manipulative habits, but only withdraws a certain necessary mass of facilitation from the total system. This facilitative control is recovered (largely by reeducation, as shown by Odin and Franz[9]), and with the recovery, the organized patterns of movement may again become functional without training. It seems that we must be dealing with two mechanisms, one of which is responsible for the integration of movements in the habit, the other for a facilitation of final common paths to make them responsive to the excitations from the former. Both are almost certainly cortical functions and both are essential conditions of the normal activity.

I suspect that some of the phenomena of motor aphasia or anarthria fall in this class of disturbances. From experiments upon movements of the tongue in speech and in silent thinking we have evidence that overt speech includes both a general increase in the tonus of the vocal organs and also a specific innervation which determines the patterns. The tonic innervation holds the tongue forward in the speaking position and in this position even during silent thinking there are sometimes involuntary movements of speech. With relaxation the tongue drops to the back of the mouth and the involuntary movements disappear. The suggestion is that Broca's area or Marie's quadrilateral provide a tonic innervation which makes the lower motor centers responsive to weaker impulses descending from the temporal and angular gyri.

A survey of the literature on motor aphasia which we have been making indicates that the severity and duration of symptoms after injury to the left third frontal convolution are proportional to the extent of destruction and independent of locus within this region. The assumption that the function of Broca's area and of Marie's quadrilateral is a non-specific facilitation of lower centers may help to clear up some of the difficulties of localization which have been encountered in study of these areas.

NON-VISUAL FUNCTIONS OF THE "VISUAL" CORTEX

In the experiments which I have thus far discussed the function of the visual cortex is visual, although exercised in various ways. We have now to consider what seems to be an entirely different function of this same area. If we subject animals to cerebral lesions and then train them in a fairly complex maze, we find that they learn much more slowly than do normal controls.[10] This slowness of learning appears, no matter in which part of the cortex the lesion occurs. The degree of retardation seems proportionate to the amount of tissue destroyed, irrespective of the locus of injury.

Fig. 2 illustrates the relationship between the extent of destruction of the cortex and the amount of training necessary to perfect the habit. The correlation is 0.84 which is as high as that between any two measures of learning ability or of intelligence that we have. The lesions included in the graph cover all parts of the neocortex and, within the limits of their statistical reliability, the data indicate that equal amounts of destruction in the motor, somesthetic, auditory or visual areas are attended by equal amounts of retardation in learning.

If normal animals are first trained in this habit and then are subjected to cerebral lesions they show loss of the habit irrespective of the locus of the lesion and in proportion to the extent of destruction. That is,

[8] Lashley, *Arch. of Neurol. and Psychiat.*, 12, 249, 1924.

[9] *Psychobiol.*, 1, 33, 1917.

[10] Lashley, "Brain Mechanisms and Intelligence," Chicago, 1929.

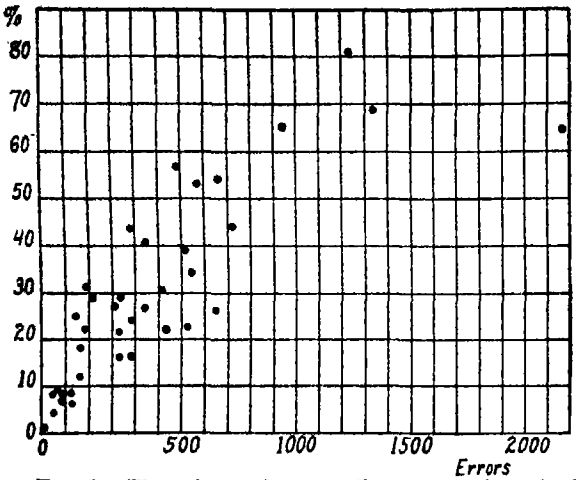


FIG. 2. The relation between the extent of cerebral lesion and the amount of practice necessary for the learning of a complex maze. The ordinates represent the percentage of the neocortex destroyed; the abscissae, the number of errors made during training to a constant standard of efficiency. The graph includes about an equal number of cases with lesions in each of the chief cytoarchitectural areas. (*After Lashley, 1929.*)

every part of the cortex plays a part both in learning and in retention.

Like other cerebral fields, the visual cortex contributes to the learning and retention of this habit of threading the maze. But in this its function is apparently not primarily visual, as shown by experiments like the following: We trained a group of animals until they reached a certain standard of accuracy in running the maze. We then blinded them by enucleation of the eyes. This produced no inaccuracy of performance. In the first tests after blinding the animals make errorless records in the maze. Another set of animals was blinded before training, and learned the maze without seeing it. They were then subjected to lesions within the visual cortex. They showed a loss of the habit—a loss as great as the loss in seeing animals after the same type of lesion. They were retrained and required an amount of practice for relearning which seemed proportionate to the extent of injury within the visual field.

These facts, that blindness does not interfere with efficiency in this activity whereas destruction of the visual cortex in blind animals does seriously interfere, indicate that in this habit the visual cortex has some important non-visual function. Since in this same manner each of the cortical fields seems to contribute equally to the maze habit, we have been led to the conclusion that the various parts of the cerebral cortex exert a mutual influence, each contributing, perhaps by some sort of facilitation, to the functional efficiency of the others, or to the functional efficiency of some lower centers which all the cortical areas supply in common.

Whether there are cortical integrative processes in the maze habit or only a general facilitation of subcortical integrative processes is not certain. There are indications, however, that the same non-specific quantitative relations obtain in the integrative activities of subcortical nuclei. Thus, injuries to the lateral geniculate bodies result in a slowing of the formation of habits based upon brightness discrimination and within our limited data the retardation seems roughly proportional to the amount of destruction.

We have been inclined to interpret this mass facilitation in the cortex as somehow underlying the intelligent activities of the organism. When we compare the effect of the same amounts of cerebral destruction upon functions of varying difficulty we find that, in general, the more complicated the function the more it is affected by a given amount of destruction. For the simplest habit (a maze with one blind alley) the extensive lesions produce little more retardation than the slight, whereas for a more complex maze the retardation is almost proportional to the square of the extent of destruction. For still more difficult functions, which seem to require of the animal something analogous to reasoning in man, Dr. Maier finds that small lesions produce more marked effects and a destruction of 20 per cent. of the cortex may entirely abolish the function.[11]

These experiments give us a picture of a cortical field in which for some activities the efficiency of performance is proportional to the quantity of tissue available and is independent of any known specialization of the parts. Moreover it seems fairly established that the complex functions of such a field may be seriously hampered by lesions which leave the simpler functions almost undisturbed.

We have further evidence on this latter point from the experiments of Dr. Carlyle Jacobsen with monkeys.[12] The animals were taught to open various latch-boxes and their rate of learning measured for simple and for combination locks. They were then subjected to destruction of the frontal lobes of the cerebrum. After the operation they remembered quite well the problem boxes on which there was a single latch to be opened and learned new problems of this type at normal rate, but when the boxes combined several of the same simple latches, the animals were unable to recall the solutions and were much retarded in relearning them. Destruction of the frontal areas generally left the capacity to deal with simple situations undisturbed yet interfered greatly

[11] *Jour. Comp. Neurol.*, in press.
[12] *Jour. Comp. Neurol.*, in press.

with the ability to handle combinations of these same simple situations. Something of the same effect appeared after destruction of the parietal association areas.

Many symptoms in man are suggestive of the same type of organization. In organic dementia we may find the ability to execute each of several simple tasks unimpaired, along with an inability to follow instructions which call for the successive execution of these same tasks. In the agrammatic aphasia of Pick there may be little or no amnesia for words but an inability to combine the words in grammatical sequence.

Boumann and Gruenbaum[13] have defined the more general defect of aphasia as an inability to keep in mind the several elements of a complex situation and at the same time to manipulate the elements in thought. With our animals there is an inability to deal with problems which present several elements at once.

Anatomical and Functional Levels of Organization

Our results with mazes of different complexity point to a functioning of cortical fields at different levels of organization. We have already clear evidence that different levels of complexity of organization may correspond to different anatomical levels (as in the case of brightness vision mediated by the thalamus and pattern vision by the cortex) and this has been accepted as a characteristic neural arrangement; the existence of hierarchies of organization in different anatomical loci. But our results with activities which probably represent the highest levels of integration of which the animal is capable suggest that for these activities there is not separate anatomical localization, but that anatomically the mechanism for the highest integrations is coextensive with the mechanisms for simpler ones. The simplification of behavior after cerebral lesions is in these cases not the result of destruction of a super-associative center, but of destruction of tissue anywhere within the cortex. The limiting condition for efficiency is the surface area or mass of cortical tissue and not the specific anatomical relations of the parts.

This is essentially the problem of the relative fragility of functions. Where one function is eliminated by a lesion which leaves other similar functions intact, it has been customary to postulate their separate localization, as in the case of color and pattern vision in man. But it seems also possible that such differential fragility may result from disturbances within a single area and that one limiting condition of the complexity of integration is the amount of available tissue.

[13] *Arch. f. d. ges. Neurol. u. Psychiat.*, 96, 481, 1925.

Non-Specificity of Histological Elements

Thus far I have dealt with gross relations of parts of the visual and other areas. What of the finer relations and the specialization of the histological elements? The separate projection of parts of the retina upon the calcarine region of higher mammals is well established and there may well be a point-to-point correspondence between the ganglion cells of the retina and the cells of the stripe of Vicq d'Azyr of the striate area. But does this mean a determination of the reaction through the specialization of these cells?

We blindfold one eye of a rat and train him to react to one of two visual stimuli. We then transfer the bandage to the other eye and test his ability to react to the stimuli with the untrained eye. The response is perfect without training. Here we have a reaction learned with one set of receptors and executed immediately with a different set. Of course the corresponding cells of the two retinae may excite the same cells of the central system, so the experiment is not crucial.

But, if we train the animal to jump to a white erect triangle and to avoid an inverted one and then confront him for the first time with outlines of these figures in smaller size, he will choose the correct outline without error. Here none of the retinal cells and consequently none of the cells of the projection area which were stimulated by the contour of the figures during training are similarly stimulated by the contours of the test figures. The habit is formed by one set of cells and immediately executed by another. It seems clear in this case that the reaction is not dependent upon the particular cells stimulated. Within limits, any cells of the visual projection area if excited in specific relation to one another can mediate the performance of an habitual act, regardless of whether they have been similarly excited during learning.

I have not time to present other examples of this same condition, but I believe that in every reaction, above the level of a spinal reflex to protopathic stimulation, the adequate stimulus is a pattern which is effective when applied anywhere upon the sensory surface and the motor response involves an equally variable grouping of motor neurons. That is, no two repetitions of the same instinctive or habitual act need involve the same pathways of conduction through the central nervous system, or the same nerve fibers excited in the same way.

Professor Herrick[14] has recently defined two types of localization.

First, a known localization of stable structural elements whose functions also are known, and, second, a localiza-

[14] Proc. Nat. Acad. Sci., 16, 643, 1930.

tion of fields within which various recurring patterns of performance or schemata, are known to be fabricated and within which inhibition, modification, or conditioning of these patterns takes place.

The second of these is the only type of localization which can be defined in the adult organism. In it the strict localization even of reflex units seems impossible. For spinal reflexes the conception of simple point-to-point connections is proving inadequate and giving place to a less specific and more dynamic interpretation. Subliminal effects, overlap of fields of influence of neurons, and the like have led Sherrington[15] to the conclusion:

> Though trains of impulses are the sole reactions which enter and leave the central nervous system, nervous impulses are not the sole reactions functioning within that system. States of excitement which can sum together, and states of inhibition which can sum together, and states which represent the algebraic summation of these two, are among the central reactions. The motoneurone lies at a focus of interplay of these reactions and its motor unit gives their net upshot always expressed in terms of motor impulses and contraction.

Thus, wherever we turn in the study of the central nervous processes we are confronted by the same problem. Just as our data show that for some functions it is massed relations of facilitation and not the specialization of separate parts which is responsible for efficiency of performance, so within the finely localized areas the ultimate element of organization can not be the single cell and its specific anatomical connections but is the interplay of organized patterns of excitation in which *relative* position and mass of excitation play a dominant rôle.

INTERPRETATIONS

The picture of cerebral functions arising from this work is not a simple one and it is still far too early to attempt any complete account of the cerebral nervous mechanisms. The point which stands out most clearly is the fact that the laws governing the activity of cerebral areas vary according to the functions involved. For pattern vision, the spacial distribution of the visual cortex is of fundamental importance and the different parts contribute diversely to the reaction. But for brightness vision, although the cerebral visual area as a whole plays an important part, its individual parts do not have a differential function but contribute equally in some unknown way to the maintenance of the habit of discrimination. In more complex functions, such as the learning and retention of the maze habit, the visual area seems essential yet nonspecific, contributing facilitation to the total neural organization yet essentially equivalent to other cortical areas. The same area may at times function as a highly differentiated system, at others as a unitary mass.

There can be little question of the facts in each case. The experimental and clinical evidence for such diverse modes of functioning seems conclusive. Our task is to find the conditions under which the different types of neural activity occur and to analyze the interactions among them. Any claim to certain knowledge of the mechanisms of cerebral function would be presumptuous, but from the known facts we may gain suggestions which will be of value in the formulation of further research and in giving at least a vague notion of how some of the simpler cerebral integrations are brought about.

The structural elements, projection and association fibers, determine the main lines of conduction and limit the regions of major excitation. The afferent projection fibers transmit their excitations to diverse parts of the cortex and, at least in the case of vision, kinesthesis and touch, reproduce on the cortex something of the spacial attributes of the stimulus. We have seen that the adequate stimulus in such cases is not the specific cells activated, but the pattern of excitation which may shift over the sensory surface and likewise over the cortical field. In such a pattern the relative intensity, distance of separation and frequency of excitations seem to be the only constant factors, determining in turn the direction and steepness of gradient of electrical and chemical processes within the system.

These patterns are certainly not transmitted in duplicate beyond the sensory projection surfaces. They give rise to specific patterns of movement but these do not reproduce the sensory pattern and we can not assume a direct connection between them over preformed and specifically differentiated paths. Yet we must assume that specific sensitivity of motor patterns to sensory patterns does exist.

We know that many of the details of motor integration are organized within the motor nuclei themselves and that the cortex does little more than activate these motor patterns, determining which of several integrated systems will respond. There are indications, further, from embryologic studies that, in their growth and early functioning, the motor systems are sensitive to the general direction of polarization of the body. It is not inconceivable that the cortex determines the reactions of lower centers, not by activating individual cells or cell groups but by determining the general direction and degree of polarization of the motor centers. There are suggestions of this in the results of

[15] Proc. Roy. Soc., 1929, B, 105, 332.

Weiss[16] with transplanted limbs of Amblystoma, in the ready shift from one limb to another in the execution of semi-skilled movements,[17] in the tendency of athetoid movements in hemiplegia to reproduce the general direction and rhythm of movements on the sound side and the like. It is as though the influences descending from the higher centers tend to call out the same direction and rhythm of movement from any motor center which they reach, regardless of whether specific associations with that center have been previously formed or not.

Turning back to patterns of excitation in the cortex, we find them projected from sensory surfaces to cortical fields in such a way that the *relative* position and intensity of activity in the various parts alone are stable. The chief interconnection of the cortical fields is through arcuate fibers which form a veritable feltwork and give little suggestion of any specific projection of one field upon another. Similarly, there are indications that the adaptive control of lower centers is in part by way of the diffusely distributed extrapyramidal fibers and the arcuate fibers of the cord. As examples, I have already cited the fact that pattern vision is mediated by the efferent fibers from the visual cortex only and may mention as an additional example that we now have animals which have learned semi-skilled acts after the section in the cervical region of all the long ascending and descending fiber tracts of the cord.

Such facts suggest that integrations above the level of the sensory fields may be in part a matter of diffusion of impulses through a fairly homogeneous matrix. In the case of any physical analogy which we can draw with this condition, such as chemical diffusion, wave motion, or the spread of timed volleys of nerve impulses through a homogeneous cellular network, there will arise within the matrix a definite and stable interference pattern in which, although the transmitted energy is in a state of constant flux, the lines or points of maximal and minimal summation and interference maintain a constant position. Such an interference pattern would in turn be capable of exciting specific groups of efferent cells and determining a definite pattern of motor innervation, or, if less specific, of altering the general polarization of lower centers and so modifying their functional activity.

This is a possible mechanism which would permit of some such degree of plasticity as the results of our experiments seem to require. It would allow of the excitation of definite motor patterns by sensory patterns of entirely different form, without the intervention of specific neural connections. It is, of course, still purely hypothetical, but it is an hypothesis which is in harmony both with the facts of localization and with the apparently contradictory facts of equipotentiality and mass action of neural tissue.

This is only a part of the whole story. There is evidence that the activity of every nervous center is conditioned by a variety of factors. Its general level of excitability varies and a low threshold or state of tonic activity is maintained by excitation from many sources. Steadiness and continuity of discharge are likewise maintained by agencies other than those which are concerned in the specific patterning of reactions. In addition, there are many indications of a preliminary integration or setting of nervous mechanisms which may then maintain a potential organization until activated by excitation from other sources. Thus it is possible, by brief stimulation of a motor point in the cortex, to modify the motor responses elicited on stimulation of distant points and such an altered excitability or motor set may persist for an hour or more before it gives way to the original pattern of response.

These processes, which we may term priming, steadying and preparatory adjustment, seem to be subthreshold for overt activity: some sort of partial activation or tonic excitation of centers. In addition to these, there are activating mechanisms which perhaps impose additional patterns of integration or perhaps only raise the tonic excitation above the threshold for motor expression.

In the motor field we have evidence that many structures participate in activity without actually determining the specific pattern of skilled movement. Thus the cerebellum, the striate complex, and probably the motor cortex contribute to the readiness and steadiness of response, though their destruction does not abolish the pattern of skilled movement. We do not know the prevalence of such facilitating activities, but our work suggests that the whole cerebral cortex, perhaps every part of the nervous system may, in addition to its specific functions, exercise such general facilitating effects upon other parts. This may account in some measure for the quantitative relations found between extent of lesion and efficiency of performance, the extent of facilitation depending upon the number of cells activated.

The apparent limitation of possible complexity of function by the available amount of tissue seems to raise a different problem. The limitation can not be due to restriction of the number of possible conditioned reflex paths available, for the animal can form as separate habits all of the elements which can not be combined in one reaction. The difficulty is in dealing with a number of elements at the same time.

[16] *Jour. Comp. Neurol.*, 40, 241, 1926.
[17] Lashley, *Psychol. Rev.*, 31, 369, 1924.

A possible clue to the situation here comes from experimental biology. In the regeneration of hydroids the number of tentacles regenerated is correlated with the size of the regenerating mass of tissue. Child has shown that each separate structure develops from a nodal point in the system of gradients within the mass. He has suggested that there is a minimal distance of separation for the development of diverse gradients limiting the number of structures which can be formed by a small piece of tissue.

In the simultaneous integration of a number of activities the cortex must present a large number of nodal points of excitation and it is possible that the number and distribution of these within the association areas is determined not by specific connections but by the polarization effects of the various localized excitations within the sensory projection fields. In such a case the number of nodes of excitation and of diverse gradient fields would be definitely limited by the factor of separation and of available mass of tissue.

I have indulged in this highly speculative discussion primarily to show that the notion of decentralization or of cerebral function without absolute anatomical localization need not involve an abandonment of recognized physiological principles or a denial of the known facts of localization. The chief advantage of the strict theories of localization has been their definiteness and comprehensibility. Those of us who have felt the inadequacy of such theories have had to fall back upon expressions like mass action, stress patterns, dynamic effects, melodies of movement, vigilance or nervous energy; all highly metaphorical and unproductive of experimental problems. Yet the facts demand something of this sort. The evidence seems conclusive that in various cortical functions there is every degree of specialization from a limited point-to-point correspondence of cells to a condition of absolute non-specificity. Not only is there diversity in the modes of action of different parts of the cortex but a single area, highly specialized and differentiated for one activity may be wholly undifferentiated with respect to another in which it also participates. We have not a choice between a theory of localization and a theory of decentralization, but must develop a wider view which recognizes the importance and interdependence of both modes of integration.

The principles to which I have appealed in the foregoing sketch, the production of gradients of activity and their influence upon organic processes, the development of stable patterns of interference in the transmission of different forces through a homogeneous matrix, are as well established in biological thought as are the principles of conduction within the nerve fiber or the interaction of nervous impulses within a spinal center. They will be capable of test with further improvement in our methods of studying the electrical phenomena of nerve conduction. Whether these specific suggestions prove right or wrong, they indicate, I believe, the direction to which we must turn our investigations, if we are to develop an adequate cerebral physiology.

OBITUARY

IGNATIUS URBAN

THE really capable and active systematic botanists of the world are so woefully few that the removal of a single one vacates a niche that usually remains unfilled. Such losses seem to have been more than normally frequent during the past year. In 1930 the world was deprived of Dr. Adolf Engler, dean of German botanists. Only a fortnight ago news was received of the death in Copenhagen of Dr. C. H. Ostenfeld. On January 7 the Botanical Garden and Museum of Berlin-Dahlem was robbed by death of another of its most brilliant men, Dr. Ignatius Urban.

Dr. Urban's special field was the flora of the West Indies, to which he devoted forty busy years. He found the Antillean flora in chaos, and left it in order. It is safe to say that for no other part of America is there available in convenient form so well ordered a mass of exact information as exists for the West Indian flora in the nine volumes of the "Symbolae Antillanae."

Those volumes by no means represent the whole extent of Dr. Urban's work, for he published many papers in German and Swedish journals. The "Symbolae" contain a vast amount of ably presented information regarding West Indian plants—descriptions of new species, monographs of genera and critical notes upon nomenclature, besides chapters upon botanical history and bibliography and plant geography. One of Dr. Urban's greatest services to science was his careful solution of the status of many vague names appearing in early literature but long neglected. He did more than any other man to place nomenclature of tropical American botany upon a solid and sane basis. His floras of Porto Rico and Hispaniola, which constitute two volumes of the "Symbolae," must be consulted almost daily by students of tropical plants.

Few botanists of all time have accomplished so much and that so uniformly well. Whoever consults Dr. Urban's own pages of the "Symbolae" will be

amazed at the wealth of painstaking detail, presented so lucidly and concisely. The descriptions of new species are models of accuracy and completeness such as scarcely a single botanist of the present generation can or will try to follow. In his ability to judge specific and generic values he had few peers. His conservative but nevertheless progressive and modern treatment of such units puts to shame the hasty and often irresponsible publications of many of his contemporaries in both Europe and America.

A fitting climax to Dr. Urban's life work was his study and description in recent years of the extraordinary collections made in Cuba and Hispaniola by Dr. Erik L. Ekman. It had been supposed by some botanists that the flora of the Antilles was practically exhausted, at least so far as discovery of new species was concerned, but Ekman's explorations showed the fallacy of such a supposition. His work in those islands revealed hundreds of new species and numerous genera quite as distinct as any ever described.

The study of these collections engaged happily Dr. Urban's youthful enthusiasm until the very time of his death. The voluminous reports upon them that have come so frequently from his pen during the last few years show that age had not abated his industry or dimmed his keen discrimination.

Dr. Urban may be envied for the fact that the end came with little warning, and that he was able to continue his habitual activity in the herbarium until the time of his death. As a friend writes, "Fortunate the man who can go in the midst of contentment, and without suffering."

American botanists who have visited Berlin will be saddened by the announcement of the death of Dr. Urban, for all of them speak of him with genuine affection and esteem. His courtesy and sympathy toward them were unaffected and unfailing.

The writer knew Dr. Urban only by his publications and through kindly letters received at all too infrequent intervals. Nevertheless, so vivid an impression of his personality did these leave that he always was felt to be an intimate friend of long acquaintance, and the news of his passing was received with a deep sense of personal loss. To the field of West Indian botany the loss is a catastrophe, for there is no promise of an adequate successor to the place which Dr. Urban held.

Paul C. Standley

Field Museum of Natural History

ERIK L. EKMAN

Scarcely had there been placed in the mail an obituary notice of Dr. Ignatius Urban, when there was received, through the kindness of Dr. R. Ciferri, an announcement of the death in the Dominican Republic on January 15 of Dr. Erik L. Ekman. Dr. Urban was so advanced in years that his loss was not altogether unexpected, but Ekman was only forty-six, and of such rugged and vigorous physique that many more years of his habitual restless activity might confidently have been expected for him.

Already trained by field work in South America, Ekman went to Cuba early in 1914, and devoted the rest of his life to an investigation of the plant life of that island and Hispaniola. Cuba, it was presumed, had been rather well explored by earlier collectors, local, European and North American, but his work proved that theirs had been far from thorough. In Hispaniola the situation was somewhat different. The island was explored botanically a century ago, but for long years afterward it was difficult to travel there. Ekman's tireless industry led him to every corner of Haiti and the Dominican Republic, to many spots which no foreigner ever had seen. He said to the writer on one occasion, "When I have finished with Haiti, it will be hard for any other collector ever to find a new species there." This boast he undoubtedly made good.

Happily, he was able to complete to his satisfaction his exploration of Hispaniola. At the time of his death he was on the point of sailing for Venezuela, where he could expect to surpass even what he had accomplished in the West Indies. What he already had done was a life work for any man. In both Cuba and Hispaniola he had discovered hundreds of fine new species, and many equally good genera, besides adding to their recorded floras scores of plants already known from elsewhere.

Ekman had as many eccentricities as characterize most other scientists. No one who met him ever could forget him. He attracted much comment in Haiti by his frugality, which was the result of the limited means at his disposal, his utter indifference to conventions and his complete absorption in his work. Would that other naturalists might emulate him in devoting more pages to science and fewer to food and weather! He was bluntly frank in speech, a consequence of his well-founded confidence in his own knowledge. He had a profound scorn for shabby and incompetent work. His specimens and his acquaintance with the plants from which they came left nothing to be desired.

The writer once had an opportunity of witnessing for a few hours the manner in which Ekman botanized. He covered a rocky hillside with the agility of a wild animal, and attacked it as if it were an adversary. Heat and storm and hardship of travel were for him beneath consideration. It was thus that he was able to explore the remotest and most difficult mountains, where others feared to go. His perfect acquaintance with every Haitian plant enabled him to recognize immediately any new one that he saw.

For that reason he shared with Dr. Urban author-

ship of many new species that he discovered. He published also numerous entertaining and scientifically valuable papers upon plant geography, especially that of Hispaniola, and he wrote an admirable monograph of the tropical American *Vernonieae*. Botanical science will be vastly poorer for loss of other contributions that it hoped to receive from his pen.

It is a strange coincidence that Urban and Ekman, the two men who have contributed most to knowledge of the Antillean flora, should have ended their labor only a week apart. Ekman's life work was one which all botanists may envy, but very few may equal. He was a brilliant member of that long line of Swedish botanists who have made such eminent contributions to natural science.

PAUL C. STANDLEY
FIELD MUSEUM OF NATURAL HISTORY

RECENT DEATHS

DR. PIERRE A. FISH, dean of the College of Veterinary Medicine at Cornell University since 1929, when he succeeded the late Dr. Veranus A. Moore, died on February 19. He was sixty-six years old on February 17.

DR. JOHN CONRAD HEMMETER, from 1903 to 1922 professor of physiology and clinical medicine at the University of Maryland, died on February 25 at the age of sixty-seven years.

PHILIP P. QUAYLE, physicist for the Phillips Cartridge Company, and formerly a member of the staff of the Bureau of Standards, died suddenly at Lebanon, Ohio, on February 21. Mr. Quayle was a recognized authority on ballistics and had written the article on Spark Photography for the new edition of the "Encyclopaedia Britannica."

THE REVEREND CHARLES DOUGLAS PERCY DAVIES, of Kemerton Grange, Tewkesbury, president of the British Astronomical Association from 1924 to 1926, died on February 5.

SCIENTIFIC EVENTS

INSTITUTION FOR SURGICAL BIOLOGICAL RESEARCH AT DOWNE

THE London *Times* states that the Council of the Royal College of Surgeons has accepted an offer from Mr. George Buckston Browne, F.R.C.S., to build and endow an Institution of Surgical Biological Research upon a 13-acre estate at Downe, Kent, which he proposes to present to the college for this purpose. At a council meeting on February 12 it was resolved that the council expressing its deep sense of Mr. Buckston Browne's great liberality, should undertake on behalf of the college to be responsible for the proposed institution, subject to an approved settlement under a deed of trust.

The estate concerned lies 16 miles from Charing Cross, adjoining the western side of Darwin's old home, "Down House," which was presented, with its 23 acres of ground, to the British Association two years ago by the same benefactor. Mr. Buckston Browne has announced his willingness to endow the new estate with an initial sum of £50,000, and to add further gifts or legacies until his total benefaction to the research institution (including the cost of the land) reaches the amount of £100,000.

In his letter to Lord Moynihan, president of the Royal College of Surgeons, and the members of the council, Mr. Buckston Browne states his belief that those who have added or are adding to the science and art of surgery are the greatest of all benefactors of the human race and the domesticated animal kingdom. He expresses, therefore, a wish to form an institution in which surgeons, and particularly young surgeons, will have full opportunity for carrying out their investigations.

The ultimate size and design of the building to be erected, and the form of equipment, service and staff are not laid down by Mr. Buckston Browne, but for the needs of the present laboratory workers, and of those surgeons who are now seeking an opportunity for testing inferences drawn from the clinical observation of certain diseases, he proposes the following initial provisions:

(1) Three or four laboratories where investigations can be made under the best conditions, or where living animals can be closely observed and cared for.
(2) Houses for animals.
(3) Accommodation for a chief attendant, skilled in laboratory methods.
(4) Accommodation for a stockman, who will look after and feed the animals.
(5) Hotel accommodation for those who may wish to carry on continuous work in the institution.

OBSERVATIONS FOR THE DETERMINATION OF LONGITUDES

A PUBLICATION has been issued by the United States Coast and Geodetic Survey concerning observations for the determination of longitudes made simultaneously in 1926 by some 30 countries. The author, Clarence H. Swick, chief of the Section of Gravity and Astronomy, gives information about a world-wide longitude net of 40 basic stations determined in 1926.

The Coast and Geodetic Survey, representing the United States, took part in this project by making the observations at 2 of the 40 stations—one near Honolulu and the other near Manila. The publication includes a description of the instruments, some of which are illustrated, and the methods employed at these two stations, together with complete details of the observations and a summary of results.

Many of the stations of the network are at astronomical observatories where elaborate equipment, such as precision clocks and large astronomical instruments, was available. The Honolulu and Manila stations of the Coast and Geodetic Survey were strictly field stations where portable equipment had to be used, and where many formidable difficulties were encountered.

For many years the determination of longitude, especially at sea, was a very serious problem. Near the beginning of the nineteenth century, prizes amounting to many thousands of pounds in value were offered by British organizations to any one who could devise more accurate methods than the ones then available.

The invention of the chronometer was the first great step in the solution of the problem, as it enabled the mariner to carry the time of his home port quite accurately and to compare this time with his time determined at sea. The difference in the two times gives the difference in longitude.

The next great improvement in longitude determination which, however, could be used only on land, resulted from the invention of the electric telegraph, which gave a means for the direct comparison of the times between some known point and a new point.

The last great advance in longitude methods came with the advent of the radio. The radio made possible a very precise comparison of times over both land and sea and was at once adopted for practically all longitude work. This was the method used for the international longitude net in 1926.

THE OHIO ACADEMY OF SCIENCE

THE forty-first annual meeting of the Ohio Academy of Science has been arranged as a joint meeting with the Indiana Academy of Science and the Kentucky Academy of Science. It will be held at Miami University on April 2, 3 and 4.

The program will conform in the main to the following outline, the details of which will be announced later:

THURSDAY, APRIL 2:

Afternoon—Short field trip to points of local interest for those who arrive in time and care to go.

Evening—An informal gathering probably with a short address on some subject of general interest, followed by a social hour for acquaintance sake.

FRIDAY, APRIL 3:

Forenoon—Short business session, Ohio Academy of Science, followed by a general scientific session with three 30-minute addresses by the presidents of the three academies. Demonstrations.

Afternoon—Sectional meetings.

Evening—Banquet, popular address, social hour.

SATURDAY, APRIL 4:

Forenoon—Short business session, Ohio Academy, followed by sectional meetings, beginning at 9:30.

Afternoon—Sectional meetings and another field trip if desired by a sufficient number.

The membership of the program committee is as follows:

Secretary: William H. Alexander, Columbus, *chairman.*

Zoology: Wencel J. Kostir, Ohio State University, Columbus.

Botany: J. Hobart Hoskins, University of Cincinnati, Cincinnati.

Geology: Frank J. Wright, Denison University, Granville.

Medical Sciences: Charles G. Rogers, Oberlin College, Oberlin.

Psychology: James P. Porter, Ohio University, Athens.

Physical Sciences: L. W. Taylor, Oberlin College, Oberlin.

Assisted by

N. E. Pearson, *chairman*, Program Committee, Indiana Academy of Science.

Alfred M. Peter, secretary, Kentucky Academy of Science.

THE YALE OCEANOGRAPHIC EXPEDITION TO THE BAHAMA ISLANDS

A STUDY of the physics and chemistry of the ocean, and the effect of various environmental factors upon deep sea life will be made by an expedition undertaken under the auspices of the Bingham Oceanographic Foundation of Peabody Museum, Yale University, to explore the water around the Bahama Islands. Plans of the expedition, of which Gifford C. Ewing, Yale '26, of New York, is sponsor and director, have been announced by Dr. Albert E. Parr, curator of the Bingham Oceanographic Collection.

The expedition has sailed for the Bahama waters on Mr. Ewing's schooner *Abenaki*, a 50-foot gaff-rigged Alden schooner, equipped with an auxiliary 50 h. p. gasoline engine giving it a speed of eight knots under power. For the purposes of the expedition a specially designed winch with 7,000 feet of 5/32 inch steel aircraft cable on a drum was installed, taking its hoisting power by chain drive directly from the main engine of the boat. By means of this winch and wire it will be possible for the expedition to carry on observations of the physics and chemistry of the ocean down to a depth of 1,000 fathoms, and an intensive study will be made by the modern method of

using a series of deep sea samplers, with corresponding thermometers, attached to the cable at different levels.

It is the purpose of the expedition to study further the physical conditions in these waters in which, in 1927, the third oceanographic expedition of the "Pawnee," sponsored and directed by Harry Payne Bingham, Yale '10, of New York City, obtained the greatest part of the valuable collections of deep sea life now deposited in the Peabody Museum as the Bingham Oceanographic Collection.

The waters around the Bahamas are known for the configuration and relative positions of the two deep sea troughs or valleys, the Tongue of the Ocean and Exuma Sound, extending in between the Bahama Islands. Running nearly parallel and very close together for almost their entire lengths, these two troughs open towards the outer ocean at opposite ends far apart from each other.

It is hoped that the *Abenaki* expedition may bring the first step forward towards a knowledge and understanding of what actually takes place between the Antilles and Brazilian currents. In this manner the expedition will also be laying the groundwork for the Yale Oceanographic Expeditions to be undertaken during 1932–1937, by arrangement between the university and Mr. Drayton Cochran, Yale '32, and by which it is hoped that it will be possible to carry through an oceanographic exploration of the entire region west of the outer chain of islands from Florida to Brazil.

Mr. Ewing, sponsor and director of the expedition, will conduct the investigations and, with the assistance of Mrs. Ewing, will take care of the observations and collections to be made on board the schooner. He will subsequently undertake the analysis and elaboration of his results in the Bingham Oceanographic Laboratory of the Peabody Museum.

SCIENTIFIC NOTES AND NEWS

THE Echegaray medal of the Royal Academy of Sciences of Madrid has been awarded to Lord Rutherford. According to *Nature* previous recipients of the medal are: José Echegaray (1907), Eduardo Saavedra (1910), Prince Albert I of Monaco (1913), Leonardo Torres Quevedo (1916), Svante Arrhenius (1919), and Santiago Ramón y Cajal (1922).

PROFESSOR SIR J. J. THOMSON, master of Trinity College, has been appointed the delegate from the University of Cambridge to the centenary of the British Association for the Advancement of Science to be celebrated in London from September 23 to 30, and to the Faraday celebrations to be held in London on September 21 and following days.

AT the University of Glasgow on January 20, Sir Frederick Gowland Hopkins, president of the Royal Society, on behalf of the subscribers, presented to Professor Robert Muir, professor of pathology in the university, his portrait by Mr. G. Fiddes Watt, and to the university a bust by Mr. G. H. Paulin. Principal Rait, who presided, expressed his pleasure that Sir Frederick Hopkins should inaugurate his presidency of the Royal Society by going to Glasgow to do this honor to Professor Muir.

M. E. FABRY has been elected a correspondent for the section of geometry of the Paris Academy of Sciences.

DR. JEAN DEMOOR, professor of physiological biology in the University of Brussels, has been elected president of the Royal Academy of Medicine of Belgium for 1931.

THE Gamma chapter of the honorary physics fraternity at Pennsylvania State College, Sigma Pi Sigma, initiated, on February 21, Dr. Artur Haas, professor of physics at the University of Vienna, as an honorary member. Dr. Haas had given three lectures at the college.

THE Lamme Medal of the American Institute of Electrical Engineers has been awarded to Dr. William J. Foster, Schenectady, New York, "for his contributions to the design of rotating alternating current machinery," and will be presented at the summer convention of the institute which is to be held in Asheville, North Carolina, from June 22 to 26. The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, who died on July 8, 1924, to provide for the award by the institute of a gold medal to a member, "who has shown meritorious achievement in the development of electrical apparatus or machinery."

DR. G. O. HIGLEY, head of the chemical department of Ohio Wesleyan University, has retired from active service. His former students are subscribing to a fund to be used for the establishment of the G. O. Higley Chemical Library.

DR. MARCUS BENJAMIN, editor of the publications of the U. S. National Museum since 1896, retired from active government service on January 31. A dinner in appreciation of Dr. Benjamin's work was given at the Cosmos Club on February 21. Dr. Charles G. Abbot, secretary of the Smithsonian Institution, presided and the speakers included Dr. R. S. Bassler, head

curator for geology, U. S. National Museum; Dr. Walter Hough, curator for anthropology, and Dr. Paul Bartsch, curator for mollusks; Mr. Martin R. Speelman, of the Government Printing Office; Dr. L. O. Howard, of the Bureau of Entomology, and General George Richards, of the U. S. Marine Corps.

Dr. Wade Hampton Frost, professor of epidemiology, has been appointed first dean of the School of Hygiene and Public Health of the Johns Hopkins University. Dr. Frost will assume his new position when the present director of the school, Dr. William H. Howell, retires on July 1. Under a new rule, adopted by the university in the creation of a deanship in place of a directorship, the administrative officer will be nominated by ballot of the advisory board of the school for appointment for three years. The dean thus appointed will be ineligible for nomination to succeed himself.

Professor J. Grover Beard, a member of the University of North Carolina faculty since his graduation in 1909, has been appointed dean of the University School of Pharmacy to succeed the late Dean Vernon Howell.

Dr. Aristides Agramonte, professor in the medical faculty of the University of Havana, has accepted the post of professor of tropical medicine at the Louisiana State University.

Dr. John B. deC. Saunders, formerly of the University of Edinburgh, has been appointed assistant professor of anatomy in the School of Medicine of the University of California.

Dr. Ralph B. Kennard, formerly head of the physics department of Robert College, Istanbul, has been appointed a research associate of the Bureau of Standards, Washington, D. C., for research work in accordance with the provisions of the Luther B. McMillan Fellowship. The privilege of establishing this fellowship as a memorial to the late Luther B. McMillan was accorded the Johns-Manville Corporation by the director of the Bureau of Standards shortly after the death in August, 1929, of Mr. McMillan, consulting engineer for the company and a pioneer in research in heat transfer problems.

Dr. N. B. Guerrant, formerly associated with the Alabama Experiment Station, has accepted a position in the department of agricultural and biological chemistry at the Pennsylvania State College, where he will be in charge of the Vitamin Research Laboratory.

The director of the Solar Physics Observatory of the University of Cambridge has, with the consent of the vice-chancellor, appointed Dr. R. O. Redman, of St. John's College, to be assistant director for five years from April 1 next.

We learn from *Industrial and Engineering Chemistry* that following thirty-five years with the Dearborn Chemical Company, Chicago, officiating in various capacities, Mr. William A. Converse retired from active service on January 1, though retaining his interest in the company. Mr. Converse is the founder of the Willard Gibbs Medal.

Dr. Charles L. Parsons, of Washington, has been appointed business manager of the American Chemical Society, of which he has been secretary since 1907. Dr. Parsons is the first incumbent of this post, created by the board of directors as a development of the society's reorganization policy. Recently the number of directors was increased from ten to fourteen, Dr. Charles L. Reese, of E. I. du Pont de Nemours and Company, Wilmington, Delaware, having been made chairman of the board.

Dr. Charles H. Halliday, epidemiologist for the Maryland State Board of Health, has been appointed commissioner of public health for the Virgin Islands. Dr. Andrew Simpson, professor of engineering at Swarthmore College, has been appointed commissioner of public works.

Dr. H. O. Forrest recently resigned as associate professor of chemical engineering and director of the Research Laboratory of Applied Chemistry at the Massachusetts Institute of Technology, to become a member of the staff of the M. W. Kellogg Company, Jersey City.

Dr. Carl E. Ladd, director of extension in the College of Agriculture of Cornell University, has been granted a year's leave of absence to become deputy commissioner of conservation for New York State. The appointment was made by Henry Morgenthau, Jr., who became commissioner under appointment of Governor Roosevelt on January 1. For the past few months, Dr. Ladd has been working on the organization of a program of economic extension work for the U. S. Department of Agriculture.

Dr. Bancroft Gherardi, vice-president and chief engineer of the American Telephone and Telegraph Company, has been elected to the presidency of the American Standards Association. He will assume the direction of the standardization activities of the organization, a task in which more than 2,000 representatives of about 500 national trade, technical and governmental groups are engaged.

Dr. F. A. Varrelman, head of the department of biology of the American University, has been granted a leave of absence for the second semester to complete research at the New York Botanical Garden.

Professor Louis Kahlenberg, president of the Electrochemical Society, recently lectured to the chem-

ists of New York and vicinity at the Chemists Club on the subject "The Electrometer in Chemistry." He also addressed the Chemists at Philadelphia on "The Separation of Crystalloids from one another by Dialysis." On the trip east, Dr. Kahlenberg installed a new section of the Electrochemical Society at Cleveland, and visited the local sections of the society at Pittsburgh and Niagara Falls. In March he will address the sections at Detroit and Chicago.

DR. S. A. MITCHELL, director of the Leander McCormick Observatory, University of Virginia, will give the second Stuart McGuire Lecture at the Medical College of Virginia, Richmond, on March 25. His subject will be "Eclipse Hunting in the South Seas." The Stuart McGuire Lecture was established a year ago in recognition of the services of Dr. Stuart McGuire to the college, to medical education and to surgery.

DR. ROY CHAPMAN ANDREWS, leader of the Central Asiatic Expeditions and vice-director of the American Museum of Natural History, New York City, will give a lecture at the museum on March 11 on "Exploration in the Gobi Desert."

DR. GEORGE F. KAY, head of the department of geology of the State University of Iowa, and state geologist of Iowa, lectured recently at Smith College and Columbia University. His subject was "The Pleistocene of Iowa."

DR. R. W. HEGNER, director of the department of protozoology at the Johns Hopkins University, gave lectures before the Iowa State College on February 23 and 24. He was also the speaker at a dinner of the society of Sigma Xi during his stay in Ames.

MR. HENRY I. HARRIMAN delivered the third Aldred Lecture at the Massachusetts Institute of Technology on February 27. He spoke on "The Meaning of the Major Business Trends of the Day." Mr. Harriman is chairman of the New England Power Company. Mr. Othmar H. Ammann gave an illustrated lecture on "Recent Progress in the Construction of Large Bridges" on March 6. Mr. Ammann is chief engineer of the Port of New York Authority and is in charge of construction of the new suspension bridge across the Hudson River.

AT a luncheon on February 28 given by the American Institute of the City of New York, the speakers were Dr. A. F. Blakeslee, assistant director of the Carnegie Station for Experimental Evolution of the Carnegie Institution, whose subject was "Biological Effects of X-Ray"; Harold G. Petsing, educational director of the Westinghouse X-Ray Company, who spoke on "New Uses of X-Ray in Industry"; Dr. William H. Meyers, director of the Roentgenological Department of the New York Post-Graduate Medical School and Hospital, whose subject was "X-Ray—Diagnostic and Therapeutic Uses."

PROFESSOR FRANZ VON GROER, director of the department of pediatrics of the University of Lemberg, Poland, is a visiting professor at the University of Illinois College of Medicine, Chicago, under the Theodore B. Sachs Memorial Fellowship. This fellowship was established through a grant from the Chicago Tuberculosis Institute. Following his work in Chicago, Professor von Groer will hold clinics and lectures at the University of Michigan, the University of Cincinnati, Western Reserve University, Cleveland, and the University of Iowa. He will then make a tour of the west, where he will lecture at the University of Colorado, the Los Angeles Academy of Medicine, the San Francisco Academy of Medicine, the Portland Academy of Medicine and the Seattle and Spokane Medical Societies.

THREE free public lectures on muscular work and fatigue, arranged by the National Institute of Industrial Psychology, under the Heath Clark Bequest, have been delivered by Dr. G. P. Crowden at the London School of Economics and Political Science.

THE Jubilee Celebration of the Society of Chemical Industry will take place in London next July under the presidency of Sir Harry McGowan.

THE International Congress of Wood Industry and Forestry will convene in Paris from July 1 to 4. It will be followed during the following week by an excursion through the Alps to the French Riviera.

Nature reports that the Faraday Society has arranged a general discussion on "Photochemical Processes" to be held in the chemistry department of the University of Liverpool on April 17 and 18. Chemists and physicists from the United States and the Continent have been invited to attend the conference and to send contributions. There will be four sessions, each with an introductory paper, which, like all the contributions, will be distributed previously, and taken as read. The four subjects are: "Molecular Spectra in Relation to Photochemical Change," "Photochemical Kinetics in Gaseous Systems," "Photochemical Change in Liquid and Solid Solutions," and "Photosynthesis." The introductory papers, respectively, are by Professor R. Mecke, Professor M. Bodenstein, Professor Berthoud and Professor E. C. C. Baly.

THE benefits of what has proved to be the most effective known fumigant for certain foodstuffs stored in quantity have just been given to the government and people of the United States by two investigators of the U. S. Department of Agriculture, Dr. Ruric C.

Roark, a chemist of the Bureau of Chemistry and Soils, and Dr. Richard T. Cotton, an entomologist of the Bureau of Entomology. This month they obtained a patent on ethylene oxide as a fumigant and insecticide, the value of which was first proved by them in April, 1927. Drs. Roark and Cotton applied for their patent just in time to secure the free use of ethylene oxide for the American public. A well-known German dye company, recognizing the great commercial possibilities of ethylene oxide, had already applied for a United States patent in addition to the German patent under which this gas is used abroad. Following a hearing before the examiner of interferences of the U. S. Patent Office, the prior claim of Drs. Roark and Cotton was recognized and the public service patent was granted to them on February 3.

THE fifth season of the Allegany School of Natural History, conducted by the Buffalo Museum of Science, in cooperation with the New York State Museum, and in affiliation with the University of Buffalo, in Allegany State Park in Western New York, close to the Pennsylvania border, will be held from July 8 to August 27. Courses will be given in field zoology, field geology, field botany, natural history of birds, and nature study. The faculty is composed of Dr. R. E. Coker, Director, Ph.D. (Johns Hopkins); Aretas A. Saunders, Ph.B. (Yale); Professor William P. Alexander, B.Sc. (Cornell), and L. E. Hicks (the Ohio State University). An instructor in field geology will be named later.

THE sixteenth annual meeting of the American Association of Petroleum Geologists will be held on March 19, 20 and 21, at San Antonio, Texas, with the Gunter Hotel as convention headquarters. The San Antonio Geological Society, which is an official section of the national association, is the host and will provide local entertainment besides field trips to the Balcones and Mexia fault lines, to Laredo and into Mexico. The national officers of the association, which now has 2,550 members, are: *President,* Sidney Powers, chief geologist for the Amerada Petroleum Corporation, Tulsa, Oklahoma; *past-president,* J. Y. Snyder, operator, Shreveport, Louisiana; *first vice-president,* R. D. Reed, chief geologist for The Texas Company of California, Los Angeles; *second vice-president,* Marvin Lee, consulting geologist, Wichita, Kansas; and *third vice-president,* Frederic H. Lahee, chief geologist for the Sun Oil Company, Dallas, Texas. The officers of the San Antonio Section are: *president,* D. R. Semmes, consulting geologist; *past-president,* Chas. H. Row, of the Sun Oil Company; *vice-president,* H. H. Cooper, consultant; *secretary-treasurer,* Ed. W. Owen, of L. H. Wentz Oil Division; and *member executive committee,* J. M. Dawson, of the Gulf Production Company. Concurrent meetings to be held with the geologists are those of the Society of Economic Paleontologists and Mineralogists and the Society of Petroleum Geophysicists.

DR. THOMAS S. BAKER, president of the Carnegie Institute of Technology, has returned after two months' travel in Europe in the interest of the third International Coal Conference which will be held at the Carnegie Institute of Technology in November. The last conference was held in 1928. Members of the advisory board of the conference include: James A. Farrell, John Hays Hammond, Samuel Insull, Frank B. Jewett, A. W. Mellon, F. A. Merrick, Auguste G. Pratt, H. B. Rust, Matthew S. Sloan, Gerard Swope and Walter C. Teagle. The program will include papers on the carbonization, liquefaction and gasification of coal; by-products; the mechanism of combustion; cleaning of coal and its preparation for the market; pulverized fuel; power plants; domestic heating, etc.

CAPTAIN DONALD B. MACMILLAN expects to sail on June 20 from Wiscasset, Maine, on his fourth expedition to the Arctic regions. He will be accompanied by a large staff of scientific men and will be followed by Sir Wilfred Grenfell, of London, who lived many years in Labrador, and Dr. Alexander Forbes, of the Harvard Medical School. Headquarters of the expedition will be established in Captain MacMillan's scientific station near Nain in Iceland. Three airplanes will be included in the equipment. One of the principal objectives is the study of glaciers to determine the possibility of the formation of another glacier age. Glaciers in other parts of the world are diminishing, but those in the far north are increasing. It would take thousands of years, however, to affect seriously the temperatures in the United States. At Nain, Labrador, a permanent base will be established. From there Commander MacMillan plans to fly inland in a cabin monoplane, capable of taking off and landing on ice caps. The expedition will be in touch by radio with New York and Chicago at all times.

THE third Marshall Field Archeological Expedition to British Honduras and Guatemala to conduct excavations on ancient Maya sites and ethnological research among the modern Mayas, sailed from New Orleans on February 20. Dr. J. Eric Thompson, assistant curator of Central and South American archeology, who led the two previous expeditions in 1928–29 and 1929–30, will again lead the expedition. The present expedition has a wider scope of operations than the earlier ones, and will remain in the field probably for a period of six or seven months. After landing at Belize, the expedition will proceed by boat up the coast to the mouth of the New River, and thence inland to the head of navigation. Thence by mule pack train and on foot the journey will con-

tinue to the site of the ancient city of Kax Uinic, which is situated on the frontier between British Honduras and Guatemala. There, with a party of Maya diggers, certain ruins will be excavated.

THE advancement of research in experimental and theoretical physics at the University of Bristol is assured by a gift of £50,000 by the Rockefeller Foundation and an offer of £25,000 by Mr. W. Melville Wills, of Bristol, to meet the stipulation of the Rockefeller Foundation. The gift is the climax of negotiations which have been going on for some time, during which representatives of the foundation have visited Bristol several times to make investigations as to the work of the Henry Herbert Wills Physics Laboratory. These convinced them that it was worthy of such liberal encouragement. Under the direction of Professor A. M. Tyndall it has won a wide reputation in the few years it has been open. It was founded by a gift of £200,000 by Henry Herbert Wills. Its founder in all gave over £680,000 to the university.

A CORRESPONDENT of the *Journal* of the American Medical Association reports that the institute for heart research established in Bad Nauheim, through a gift of Mrs. Louise G. Kerckhoff, of Los Angeles, is nearing completion and can probably be opened the coming spring. The new institute, named after the donor of the "Kerckhoff-Institut," will be in charge of Professor Groedel of Bad Nauheim. There will be four departments: a department of examination and diagnosis for patients of the social insurance system; a department for the collection of statistics on the causes of heart disease; a department for public enlightenment as to the causes and the best methods of combatting heart disease, and a department for experimental pathology and therapy of heart disease. An administrative council composed of federal representatives, the chairman of the bureau of insurance of Hesse, and representatives of neighboring universities and members of the medical profession will manage the institute.

ON February 3 the Congregation of the University of Oxford passed a decree accepting the offer of the Forestry Commission and the Secretary of State for the Colonies to make contributions at the rate of £5,000 a year as from March, 1929, to July, 1931, to the maintenance of an Imperial Forestry Institute in Oxford, the university undertaking to make during the same period contributions to the Department of Forestry at a rate not exceeding £300 a year in addition to its current contribution. Mr. C. G. Morison, in proposing the decree, explained that it is a renewal of a former decree. The institute, which has now been in existence for about five years, is active in research and in giving post-graduate instruction. The relations between the institute and the university are at present engaging the attention of council.

THE possibility of establishing an insecticidal plant industry in the Virgin Islands to supply this country with important insecticidal materials, which are now imported at high cost from foreign countries, will be investigated by Dr. W. W. Skinner, assistant chief of the Chemical and Technological Research Unit of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, who left Washington for the islands on February 26. Dr. Skinner goes to the Virgin Islands at the request of the Department of the Interior which recently was placed in charge of the islands and which is seeking to rehabilitate the agriculture by the introduction of new industries to take the place of the production of oil of bay and sugar. These were formerly the leading native industries but have recently been suffering from the world depression and the over-production of sugar. Dr. Skinner will investigate the possibility of aiding the islanders to rehabilitate the bay-rum industry by assistance of a chemical character; he will study the situation with regard to the production of sugar; and particularly he will investigate the possibilities of growing such insecticidal plants as pyrethrum, derris, and "cube," and the extraction from these plants of valuable insecticidal materials. He will also consider the advisability of establishing a chemical laboratory to aid such developments in the islands.

DISCUSSION

ISOLATION OF PROTEIN CRYSTALS POSSESSING TRYPTIC ACTIVITY

A CRYSTALLINE protein has been isolated from commercial preparations of "trypsin" which digests casein and gelatin in neutral solution. The digestive power of the crystals is about ten times that of the most active commercial preparations and the activity remains constant through three successive crystallizations. The substance, however, is exceedingly unstable and unless care is taken it becomes less active during the course of the preparation. It is obtained by extraction of the crude preparation with one quarter saturated ammonium sulfate. The extract is brought to one half saturated ammonium sulfate and filtered. The filtrate is saturated with ammonium sulfate and the resulting precipitate filtered off and redissolved in cold one quarter saturated ammonium sulfate. Saturated ammonium sulfate is added slowly with stirring to faint turbidity and the solution is brought slowly to 25° C. Small square platelets which tend to form

chains or clumps appear in the course of about an hour and crystallization is complete in two or three hours.

John H. Northrop
M. Kunitz
Laboratories of The Rockefeller Institute for Medical Research,
Princeton, New Jersey,
February 8, 1931

YELLOW-SPOT DISEASE OF PINEAPPLES TRANSMITTED BY THRIPS TABACI LIND.

Experimental evidence has been obtained by the writer that an insect identified as *Thrips tabaci* Lindeman is a major vector operating in the field occurrence of a destructive disease of pineapple plants in the Hawaiian Islands, and furthermore, that this insect carries the virus to pineapple from certain weeds of which *Emilia flammea* Cassini now appears most important. Hitherto no means of transmission of this disease has been known. This preliminary note summarizes the evidence which will be published in detail in the near future.

The yellow-spot disease of pineapples is an infectious chlorosis with some distinctive and striking characteristics. In many respects it resembles diseases of both mosaic and ring-spot types, while in others it stands alone. Symptoms begin with a distinct "initial spot" with which thrips egg-punctures and feeding injury are generally associated. This spot, of about 5 to 20 mm diameter, is characteristically circular or rounded in outline, chlorotic and somewhat hypertrophied. Often it is concentrically banded dark and light. Extending down the leaf from this initial spot and developing on the younger leaves of the plant are chlorotic stripes and circular spots, sometimes strikingly zonate. Occasionally a coarse mosaic pattern develops in plants that have been long diseased. Pronounced dwarfing occurs as in many virus diseases. In this case the dwarfing is commonly unilateral, and leads to a marked curvature of the plant. Necrosis and rotting of affected parts follow, leading to death and decay of the plant within a few weeks. Microorganisms, apparently wholly secondary, are involved in this breakdown, although none have been detected in earlier stages.

Closely associated with yellow-spot in its field occurrence is a virus disease of *Emilia flammea* which likewise shows both ring-spot and mosaic characteristics. Thrips (*T. tabaci*) collected from this diseased weed in the field and allowed to feed upon healthy pineapple and Emilia seedlings have transmitted the virus, producing yellow-spot in pineapple and ring-spot mosaic in Emilia. Furthermore, thrips reared through several generations in the greenhouse on diseased Emilia plants have similarly proved infective.

For critical experimental testing, pedigreed non-viruliferous colonies of this thrips were established. These colonies were started from a single larva each, which was removed to an insect-free seedling of Emilia or of *Pisum sativum* L. at the moment of hatching and before feeding had begun. Thrips from such colonies, when tested on both Emilia and pineapple seedlings, have proved non-infective. When, however, these non-viruliferous thrips have been allowed to feed on diseased Emilia plants they have acquired the virus which they have later transmitted to both Emilia and pineapple, producing typical symptoms in a high percentage of plants.

Preliminary evidence indicates that certain plants in addition to Emilia may be sources of the yellow-spot virus, but it appears that this one plant, because of its abundance in pineapple fields and because of its suitability for the rapid reproduction of thrips during certain seasons, is now of major importance. The feeding of this insect upon pineapple plants appears to be quite incidental, and therefore it is probable that any natural transfer of the virus from pineapple to pineapple is relatively uncommon.

This is not the first well-established case of virus transfer by one of the Thysanoptera. Pittman[1] (see also the report by Dickson[2]) has already demonstrated a thrips (*Frankliniella insularis*) to be the vector of spotted wilt of tomatoes in Australia.

Maurice B. Linford
University of Hawaii

FRACTURING AND MOVEMENT IN ROCKS WITHOUT APPARENT DISPLACEMENT[1]

A rather unusual kind of rock deformation has been found along one of the branches of Bluff Creek in the southeastern part of the Nortonville quadrangle about thirteen miles northeast of Hopkinsville, Kentucky. The rocks at this locality exhibit typical features of faulting but show no dislocation of the beds. They are abundantly grooved and slickensided, showing the effects of movement under compressive force, but bedding planes can be traced across the breaks with none or at the most not more than one or two inches of dislocation. All the features of faulting are the results of components of vertical movement. Careful examination has failed to reveal any trace of either oblique or horizontal movement parallel to the

[1] H. A. Pittman, "Spotted Wilt of Tomatoes," *Jour. Council Sci. and Industrial Res.* (Australia), 1(2): 74–77, 1927.

[2] B. T. Dickson, "Spotted Wilt of Tomatoes," in "The Work of the Division of Economic Botany for the Year 1928–29," *Council Sci. and Industrial Res.* (Australia) *Pamphlet*, 14: 18–19, 1929.

[1] Published with the permission of the director of the Kentucky Geological Survey.

fracture surfaces. The area of deformation is located in a region where faulting is rather common so that the fracturing is not out of the ordinary. The unusual feature, however, is the absence now of any displacement along the lines of fracture.

The formations involved in the deformation are the Glen Dean limestone and Tar Springs sandstone of the Chester series of Mississippian age. The general dip of the rocks in the surrounding territory is about one degree in a northward direction. The Glen Dean limestone dips under about one fourth mile down stream from this locality. In the area of disturbance the rocks are folded into a small anticline, the trend of whose axis is at right angles to the general dip direction. The amount of elevation in the fold is small, approximately twenty feet, being sufficient to bring the Glen Dean limestone again to the surface in the bed of the creek. The fold is asymmetrical with the steeper dip, about three or four degrees, on the south and a lesser dip, about two degrees, on the north flank. The zone of deformation is parallel to the axis of the fold and is on the steeper, southern flank.

In the zone of deformation, which is about twenty feet in width, the Tar Springs sandstone has been fractured along a number of surfaces which have dips ranging from seventy degrees to vertical. Some are inclined toward the south and others toward the north, but the strike of all of them is essentially parallel to the axis of the fold. Some of the inclined breaks intersect and even at the points of intersection there is no offsetting of the breaks or of the beds. Some of the breaks are closely spaced, two to four inches apart, while others are several feet apart. Almost all of them exhibit effects of movement, the fracture surfaces being grooved and polished. The walls of many of the surfaces of movement are not now in contact, some of the breaks being open as much as an inch. How much movement there may have been along these lines of fracture it is impossible to say.

The following explanation is offered for the phenomenon. At the time of folding of the rocks the south flank of the anticline broke along this zone, the pressure being sufficient to cause enough movement to polish and groove the sandstone. With a decrease in the folding pressure the dislocated beds moved back to their original positions so that, while the effects of pressure and movement are clearly preserved, the beds show no dislocation or at the most only a very little. An alternate hypothesis is that the beds may have been in movement up and down along the fracture surfaces several times during the period of deformation. Due to the weight of overlying sediments and the inherent elasticity of the folded rocks, they tended to return to a more flattened attitude during such times as the deformative force was diminished. After deformation, the diminished compressive force allowed the beds to return to the relative positions they occupied before breaking. Although oscillatory movements along faults and partial returns to the original positions are known to have occurred, the writer knows of no other instance where the amount of recovery has so nearly equalled the amount of deformation.

A. H. SUTTON

UNIVERSITY OF ILLINOIS

AN UNUSUAL RAINBOW

A REMARKABLY brilliant rainbow appeared to the northeast of Tucson, after a hard shower about 4 P. M. on February 13, 1931. This rainbow was out of the ordinary in that a repetition of the spectrum showing first, second, and third order colors in the same sequence occurred on the inside of the rainbow, as well as a fainter secondary reversed rainbow about 10 or 15 degrees outside of the primary arc. The brilliance of the rays of the sun in our southwest is no doubt responsible for the observance of this unusual phenomenon.

ROBT. E. S. HEINEMAN,
Assistant Geologist

UNIVERSITY OF ARIZONA

SCIENTIFIC BOOKS

Thomas Say, Early American Naturalist. By HARRY B. WEISS and GRACE M. ZIEGLER. Foreword by L. O. Howard. Springfield, Illinois, Chas. C. Thomas. 260 pp.

SAY died in 1834, so that nearly a hundred years have been allowed to pass before the publication of a really satisfactory biography. Every zoologist and more particularly every entomologist and conchologist, has been familiar with the name of Say, with a more or less vague understanding that he was one of the founders of the science in America. The eccentric naturalist, in Fenimore Cooper's "Prairie," illustrates the once prevalent attitude toward the zoological explorer. The present book describes Say's life in the environment of his time and we may well marvel at his steadfast zeal, his ability in overcoming obstacles, the excellence and volume of his work. Aided by his friend and patron, William Maclure, he managed to accumulate a good library of zoological works, especially those in which American animals were described

by European authors. He corresponded with zoologists on both sides of the Atlantic and made every possible effort to avoid the publication of synonyms. He visited Colorado with Long's Expedition, and also carried on explorations in the northwest, as a member of the expedition of 1823 to "the source of St. Peter's River, Lake Winnepeek, Lake of the Woods, etc., etc." With Maclure he traveled to Florida (1817–18) and Mexico (1828). As the result of all these activities he was enabled to describe considerably over a thousand new species of American beetles, over four hundred insects of other orders, a large proportion of our common shells, as well as crustaceans, birds, mammals, reptiles and a certain number of fossils. His work has stood the test of time, and his species are for the most part currently recognized. Mrs. Say, who survived until 1886, drew the figures on sixty-six plates to illustrate Say's Conchology, and the figures were colored by hand with the aid of some pupils.

When Robert Owen established his socialistic community at New Harmony, Indiana, Maclure was drawn into the undertaking, believing that he could make the place the center and fount of American education. Say accordingly left Philadelphia and became a resident of New Harmony. We are told how disputes arose and the experiment ended in failure, as perhaps ought to have been foreseen from the beginning. But Owen's sons remained to do distinguished work in America and in a large sense the idealism of the movement was not wasted, but has continued to bear fruit down to the present time. Even the lessons derived from its failure have been valuable.

Say's shells are for the most part in the Academy of Natural Sciences at Philadelphia, but of his insects it seems they have only one specimen, the type of the famous White Mountain butterfly. The insects were destroyed by dermestids, and although it is not so stated, must have been thrown away after Dr. T. W. Harris returned the ruined collection to the Academy. It was not understood at the time that even the fragments would have been of great value to posterity. Fortunately the species were so well described that there is usually little dispute concerning their identity. It was however a defect in Say's work that he was accustomed to cite localities very vaguely. The book represents a very large amount of work and is full of interest. Every student of American zoology should read it, and then Dall's "Life of Baird," and thus learn how the science was developed in this country during the nineteenth century. It is a story of enthusiastic workers overcoming difficulties which seem terrific to us in these relatively easy days. When we are inclined to complain of the obstacles in our way, it is good discipline to turn to the life of such a man as Say, and see how he conquered what seemed to be the iron hand of fate.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO,
BOULDER, COLORADO

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW SINGING TUBE

LAST April, while making a piece of apparatus from pyrex capillary tubing, I noticed that a piece about 10 cm long and 2 mm inside diameter began to emit a musical note when the bulb which I was blowing on the end reached a volume of approximately 2 cubic centimeters. Recalling that Dr. C. T. Knipp, of the University of Illinois, had developed a singing tube some ten years ago, I assumed this to be what he had observed.

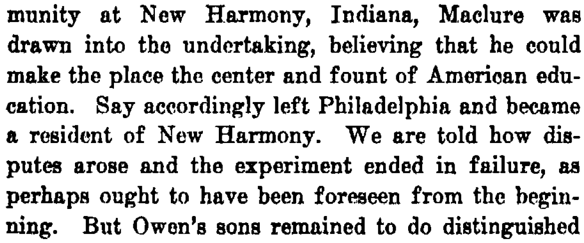


FIG. 1

On running across an account[1] of Professor Knipp's tubes recently, however, I think the difference in the two cases is worthy of notice. His tubes as reported were all substantially of the form of an ordinary mercury trap.[2] It appears that this special form is not necessary: a tube with a bulb on one end and the other end open (*A*, Fig. 1), or with the bulb in the middle and both ends open (*B*, Fig. 1) will sing, with various shapes of bulb. The note emitted appears to depend chiefly on the volume of the bulb and tube, the temperature at the junction (*J*) of bulb with tube, and the diameter of the tube.

The phenomenon has been observed with tubes of various lengths and from 1½ to 4 mm inside diameter; but outside these limits it has not been detected. When the junction of the bulb with the tube is heated to about the temperature of redness the oscillations begin. Heating elsewhere is not effective until this temperature is attained at the junction.

A tube 13 cm long, 2.3 mm inside diameter and having a bulb of 1.8 cubic centimeters (approxi-

[1] *Phys. Rev.*, xii, December, 1918, p. 191.

[2] SCIENCE, April 22, 1921, p. 393.

mately) emits middle C. As the temperature at the junction is increased the pitch is raised; but it has not been determined whether this is due to the temperature alone or to the gradual shrinking of the bulb, as the temperatures required are above that at which pyrex softens. To avoid this difficulty, it is planned to continue the investigation using tubes of quartz.

F. L. ROBESON

VIRGINIA POLYTECHNIC INSTITUTE

A SIMPLE MICROSCOPE EYEPIECE POINTER

THE use of an eyepiece pointer to augment the value of a demonstration under the microscope is usually appreciated by both student and instructor in the laboratory. The customary procedure of gluing a short hair to the rim of the ocular diaphragm is simple and effective. When, however, the eyepiece is in demand both with and without a pointer, the necessity of having to adjust the hair each time is highly inconvenient.

To meet the need for a pointer that could be readily inserted and removed from the ocular, the writer has devised the accessory here described.

A round 18-mm coverglass, free from imperfections, is selected and cleaned with acid alcohol. This forms a base upon which a pointer may be mounted. The pointer itself is drawn from a thin glass rod to a fiber-like thickness. With a little care and practice the glass can be drawn to a diameter appreciably less than that of even a fine human hair.

The tapered end of the pointer is then placed on the base, a drop of Canada balsam added followed by a second coverglass, likewise perfectly clean. By means of the protruding end of the pointer its tip may be centered and its axis adjusted parallel to the radius of the two coverglasses. In this way the fine rod is sealed, free from disturbance between the two coverglasses. After the protruding end of the pointer is snapped off the finished product results.

If actually embedded in the balsam the glass pointer appears highly refractory when viewed through the microscope. If this is objectionable, the pointer can be held in place by applying the cement only to the edges of the coverglasses. When so mounted it is seen as a black line.

A dozen or so of these pointers can be made and mounted in half an hour and they may then be kept permanently on hand for instant use when needed.

JAMES A. LOUNSBURY

DEPARTMENT OF BOTANY,
MARQUETTE UNIVERSITY

SPECIAL ARTICLES

OBSERVATIONS CONCERNING THE CAUSATIVE AGENT OF A CHICKEN TUMOR[1]

IN early publications on the chicken tumor group, some of the properties of the filterable agents causing these neoplasms were described. Recently additional observations have been reported from this laboratory which may be summarized as follows: The agent of Chicken Tumor I, a spindle-cell sarcoma, is selectively adsorbed and fixed by certain mesodermal tissues from susceptible animals, but not by similar tissues from non-susceptible animals. The plotted curve of the amount of ultraviolet light of selected wave lengths required to inactivate the tumor agent shows a significant qualitative and quantitative variation from the curves for bacteria, typical viruses and bacteriophage. The tumor producing activity of the tumor filtrates can be precipitated out with a protein fraction and somewhat purified.

Certain extensions of the work will now be recorded.

Steps in Purification of the Tumor Agent

Precipitation. As already reported, the agent active in a tumor filtrate can be precipitated out by electrodialysis or by increasing the hydrogen-ion concentration with acid or buffer. The pH at which the precipitate comes down is between 4.4 and 4.8. It carries all of the agent with it and can be dissolved in alkali and reprecipitated repeatedly without destruction of the agent.

The average amount of nitrogen in the precipitate is about 12 per cent. and varies little with the method of preparation of the extract. The phosphorus ranges from 0.16 per cent. to 0.69 per cent., being lower when the extract is prepared with water and higher when an alkali or Ringer's solution extract is used. Hydrolysis of the precipitate shows the constant presence of a considerable amount of reducing substance in all the active precipitates tested. The Feulgen reaction is positive, becoming more intense with each reprecipitation of the material. With the Mallory connective tissue stain the first precipitates give generally a maroon red, tending more to yellow red with the specimens showing a stronger Feulgen reaction.

Purification by Adsorption. Adsorption on colloidal aluminum hydroxide, a method already employed by other investigators, was utilized in attempts to purify the agent. The results were disappointing in that so little of the agent could be released after adsorption that inoculation produced at best tumors much smaller and less vigorous in their growth

[1] From the laboratories of the Rockefeller Institute for Medical Research.

than those resulting from injections of comparable amounts of the original extracts. The point of importance which developed from this study was that, after centrifuging out the aluminum hydroxide with its adsorbed materials, the supernatant fluids proved to be far more active than the full strength extracts. In fact, it is the most active material so far obtained, and this in spite of the fact that an appreciable quantity of the agent is taken down with the aluminum hydroxide.

When there has been a proper ratio of aluminum hydroxide (Willstätter Type C) to tumor extract, the supernatant fluid just mentioned is viscous, generally opalescent but often water clear. No precipitate is produced by acetic, tungstic, tannic or chloracetic acids. It gives negative Biuret, Millon and Xanthoproteic tests and only a slightly positive Ninhydrin reaction. Analysis shows an average nitrogen content of 0.050 mg per cc and a reducing substance figured as glucose of 0.175 mg per cc. The form in which the nitrogen occurs in this fluid is as yet undetermined, but the failure to induce sensitization in guinea pigs by the injection of large amounts suggests that it is either non-protein in nature or is a protein lacking antigenic properties.

Evidence exists that the viscosity of the supernatant fluids is due to the presence of a substance resembling chondroitin sulphuric acid. An attempt has been made to remove this substance by combining it with a basic protein. When the latter is precipitated out it takes with it all of the viscous material, leaving a water-clear, limpid fluid, which retains a tumor producing activity at least equal to that of the original supernatant fluid before removal of the viscous material, and far more so than the original concentrate. Chemical study of it is not yet complete.

Antigenic Properties of the Tumor Agent

The literature on the antigenic properties of the tumor producing agents will not be reviewed, since our study is concerned only in relation to the steps in the purification of the active principle. By the injection into rabbits of a concentrated Berkfeld filtrate of a water extract of the chicken tumor a good precipitating serum was obtained, which proved capable of neutralizing the tumor producing activity of a tumor extract. It was then found that the protein fraction of such a tumor filtrate, prepared as already described, was also effective in calling out precipitating and neutralizing antibodies in rabbits. A Berkfeld filtrate of an extract of tumor in Ringer's solution induced the formation of precipitins and neutralizing bodies, but the active protein fraction of this Ringer's extract failed to induce definite precipitins, though the neutralizing power of this serum was as good as that of the other sera. That the neutralizing power of these various sera was not referable to ordinary anti-chicken protein antibodies was shown by the failure of a strong anti-chicken serum of the rabbit to neutralize the activity of the tumor agent.[1]

After the development of the method of preparing highly active tumor extracts practically free of protein, the antigenic properties of such material were tested, the full strength concentrate being employed as control material. The sera of the rabbits injected with this latter contained precipitins and complement fixing antibodies, and they neutralize active tumor filtrates. The sera from rabbits immunized with the purified material showed no precipitins, no complement fixing antibodies, gave negative Ramon flocculation tests, but were more strongly neutralizing to the active tumor extracts then the sera developed against the full extract. The interpretation of this result must await further study.

Evidence of an Inhibiting Principle in the Chicken Tumor

The occasional occurrence of an inactive tumor filtrate or extract of dry tumor material has been noted by a number of workers. Several such inactive preparations were encountered in the course of our study of the acid precipitates. It was noted in these cases that the protein fraction gave a negative or faintly positive Feulgen reaction, and showed an excess of blue colored material with the Mallory stain. This observation suggested the possibility that the inactivity of an extract might be due to the presence of an inhibiting substance. An experiment was undertaken to test the possibility that this inhibitor might be more soluble than the active material. The dry powder of the chicken tumor was thoroughly extracted with water, centrifuged and the sediment extracted a second time with water. The second extract proved more active in the production of tumors than the first. The sediment of the second extract treated a third time with water yielded an extract even more active than the second. The result might mean simply that the active material was difficultly soluble, more of it going into solution after the long treatment with water. That this is not the correct interpretation is indicated by the observation that the residue inoculated after the first extraction was less active than the residue after the second washing, and this in turn less active than the residue after the third washing. In fact the residue reached maximum activity only after being extracted four times with water. In this connection the finding should again be mentioned that the fluid left

[1] These studies were carried out with the assistance of Dr. D. C. Hoffman.

after the adsorption with aluminum hydroxide as above described is markedly more active in tumor production than the most concentrated filtrate, although some of the tumor producing material is carried down with the aluminum. No other explanation seems possible than that both tumor producing principle and some substance or condition inhibiting its activity existed in the fluid prior to adsorption with aluminum hydroxide, the process removing far more of the inhibitor than of the principle. While there is less activity in the aluminum supernatant fluid than in the original extract, yet, unhampered by the inhibitor, it is more active.

The details of the experiments and a discussion of the results will be published later.

JAMES B. MURPHY
O. M. HELMER
ALBERT CLAUDE
ERNEST STURM

THE DEHYDROGENATION OF CHLOROPHYLL AND THE MECHANISM OF PHOTOSYNTHESIS

IN a recent paper,[1] it was shown that the allomerization of chlorophyll is essentially a dehydrogenation (oxidation) reaction. We have now been able to obtain additional evidence in favor of this view in a study of the dehydrogenation of the magnesium-free compound methyl phaeophorbide *a*. In a pyridine-acetone solution this compound is oxidized by potassium molybdicyanide; approximately two equivalents of reagent are required per mole. The product (methyl dehydrophaeophorbide *a*) yields the same hydrolysis products with hot alkali as allomerized phaeophorbide, and like this substance is not further oxidized by molybdicyanide. The difference between the spectra of methyl phaeophorbide *a* and methyl dehydrophaeophorbide *a* is slight in the visible range, but considerable in the near ultraviolet.

These facts, which prove that the chlorophyll molecule contains an easily dehydrogenated group, suggest at once a possible mechanism for photosynthesis. Emerson's recent work[2] has proved that chlorophyll is involved in the so-called Blackman dark reaction, and hence must be a participant in some strictly chemical step in the photochemical process. We suggest that this step is the reduction of carbon dioxide by chlorophyll itself, the other product being dehydrochlorophyll. In order to make the system chlorophyll-dehydrochlorophyll mobile, an enzyme would undoubtedly be necessary; this would account for the sensitivity of the Blackman reaction to hydrocyanic acid. The regeneration of chlorophyll would require energy furnished by the light. The steps can be represented thus:

Ch = chlorophyll
Ch(−2H) = dehydrochlorophyll

(1) Dark reaction

$$12\ \mathrm{Ch} + 6\ CO_2 + \text{enzyme} \rightarrow 12\ \mathrm{Ch}(-2H) + \underset{\text{glucose}}{C_6H_{12}O_6} + 6\ H_2O$$

(2) Light reaction

$$12\ \mathrm{Ch}(-2H) + \text{light} + 12\ H_2O \rightarrow 12\ \mathrm{Ch} + 6\ O_2$$

This mechanism would appear to account for most of the facts now known about photosynthesis, including Warburg's experiments with a rotating sector. A calculation of the free energy of reduction of carbon dioxide (in the atmosphere) to glucose (in dilute solution) yields information in regard to the necessary reducing intensity of the chlorophyll-dehydrochlorophyll system if it is to function in reaction 1. A reducing intensity of 50 millivolts greater than the hydrogen electrode would be sufficient for reaction 1 to run very far towards completion. A reducing intensity equal to the hydrogen electrode would produce glucose in a thousandth molar solution, if the ratio of chlorophyll to dehydrochlorophyll were kept at about 100 to 1 in a steady state by a combination of reactions 1 and 2. Presumably the glucose or other primary reduction product of carbon dioxide is removed continually from the reaction by a series of irreversible processes. These calculations and a more detailed discussion will be published in full elsewhere.

J. B. CONANT
E. M. DIETZ
S. E. KAMERLING

CHEMICAL LABORATORY,
HARVARD UNIVERSITY

[1] Conant, Hyde, Moyer and Dietz, *J. Am. Chem. Soc.*, 53: 359, 1931.

[2] Robert Emerson, *Jour. Gen. Physiol.*, 12: 609, 623, 1929.

BOOKS RECEIVED

HOUSTOUN, R. A. *A Treatise on Light.* Seventh edition, revised. Pp. xi + 494. Two plates and 340 diagrams. Longsmans, Green. $4.00.

MACKIE, T. J., and J. E. MCCARTNEY. *An Introduction to Practical Bacteriology.* Third edition, revised. Pp. xv + 421. Illustrated. William Wood. $3.50.

MELLO-LEITÃO. *Aphantochilidas e Thomisidas do Brasil.* Pp. 359. 28 plates. Archivos do Museu Nacional, Rio de Janeiro.

RUTHERFORD, SIR ERNEST, JAMES CHADWICK and C. D. ELLIS. *Radiations from Radioactive Substances.* Pp. xi + 588. 12 plates. 138 figures. Macmillan. $6.50.

SLEVIN, JOSEPH R. *Log of the Schooner "Academy" on a Voyage of Scientific Research to the Galapagos Islands.* Pp. 162. 16 plates. California Academy of Sciences, San Francisco. $3.00.

SPEARMAN, C. *Creative Mind.* Pp. xii + 162. 16 plates and 6 figures. Appleton. $2.00.

STEPHENSON, J., Editor. *The Fauna of British India Including Ceylon and Burma.* Cestoda, by T. Southwell. Volume II. Pp. ix + 262. 355 figures. Taylor and Francis, London. 15/.

Tôhoku Imperial University. Science Reports. First series: Mathematics, Physics and Chemistry. Volume XIX. No. 6: Pp. 681–800 + 7. Illustrated. Maruzen Company, Tokyo.

SCIENCE

VOL. 73 FRIDAY, MARCH 13, 1931 No. 1889

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE RELATION OF PHYSICS TO CHEMISTRY[1]

By Dr. N. V. SIDGWICK

OXFORD UNIVERSITY, NON-RESIDENT LECTURER IN CHEMISTRY AT CORNELL UNIVERSITY UNDER THE GEORGE FISHER BAKER FOUNDATION

I AM very grateful to Cornell University and to Professor Dennis for inviting me to join your staff as non-resident lecturer and for the kindness with which you have received me. It is a high honor to have one's name added to the distinguished list of the Baker lecturers. A lectureship of the kind founded by Mr. Baker is, I think, of real service both to the hosts and to the guests. Francis Bacon gives as one of the three chief conditions of scientific progress "conjunction of labor," the intercourse of scientific men, whereby, as he says, "the frailty of man may be supplied." With the progress of knowledge every branch of it becomes more specialized and yet at the same time more dependent on other branches, and the only way in which the workers in any laboratory can get a true sense of the values of the different kinds of chemical work which are being pursued all over the world is by intercourse with chemists from elsewhere. The benefit to the visitors is equally great, especially when it makes them acquainted with so admirable a laboratory and so distinguished a staff of chemists as you have here. I also appreciate greatly the opportunity of studying your methods of teaching and administration; the only way to find out how a university works is to join its staff, and take part in its labors.

I have chosen "The Relation of Physics to Chemistry" as the subject of my introductory lecture, because it seems to me that there is none on which, in

[1] Introductory public lecture.

the present state of knowledge, it is more necessary that we should have clear views. While it is common to hear men deploring the increase of specialization, through which, they say, one scientific man can scarcely understand what another is doing, it is nevertheless true that the two great sciences of chemistry and physics have now reached a point at which they are attacking identical problems. The task which we as chemists have before us is no light one; neither chemists alone, nor physicists alone, can solve the problems which face us. We must make use of every assistance that we can get, and the most powerful is that of physics. But if we are to use this to the best advantage, we must understand clearly what it is, and in what ways it can help us.

It is a commonplace that all knowledge is one; its division into separate sciences is an unfortunate necessity, arising not so much from the subject-matter as from the limitations of human capacity. The field is so wide that no one can command the whole of it, and its students naturally break up into groups which concentrate on particular provinces and evolve particular methods for dealing with them. This means in practice that the various branches differ quite as much in the methods of attack as in the problems attacked. Among the sciences concerned with non-living matter, there are the three familiar divisions of mathematics, physics and chemistry. Mathematics deals with number, space and time, abstracted from all questions of what it is that is numbered or what occupies the space; physics with the properties of matter, and primarily with those common to various forms of matter; chemistry with the properties of various forms of matter as related to their chemical composition. But these definitions, as you can see, are very imperfect; in fact, no exact boundaries can be laid down. Each science is crossing the frontiers of the next, and in recent years the interpenetration has been very rapid. Mathematics is becoming physicized; the word ether, which, when I was young, was used to distinguish real or physical from ideal or mathematical space, has almost disappeared, not because the concept of ether has been abandoned, but because we are more interested in real space than in imaginary spaces that might exist. Space and time are no longer independent entities, and for a knowledge of their interrelations we appeal not to *a priori* ideas, but to observations of the positions of stars and the wave-lengths of their light.

If the line separating mathematics from physics is blurred, that between physics and chemistry has vanished. Both sciences are now examining the same problems. It is true that they use different methods, but they apply them to the same materials. It is therefore of fundamental importance for us as chemists that the light which the physicists throw on our problems should illuminate them for us as well as for the physicists.

The distinction between different sciences depends on a very obvious fact, that the simpler the problem you are examining, the more precise is the knowledge you can acquire of it—in philosophical language, the less the extension, the greater the intension. The simplest problems of all are those of the mathematician. His materials—number, space and time—are uniform in behavior; he can isolate his problems from all outside interference. Hence he can state his results with the greatest certainty and accuracy, and carry his analysis to the greatest lengths. The physicist has a more complicated task; he has to take account of the differences in behavior of different forms of matter and of the small disturbances to which any actual system, however carefully isolated, is subject; and he must reckon with the imperfection of his measuring instruments. He is therefore often obliged to be content with approximations to the truth. The chemist is faced with still greater complications. While the physicist can restrict his inquiry to simple systems and to the materials which he finds most tractable, the chemist is compelled to extend his work to all forms of matter, or let us say in the first instance to all pure substances. Having this great mass of material to handle, his knowledge of its behavior is necessarily less detailed, less accurate, less deducible from first principles than that of the physicist, and in a still higher degree than that of the mathematician.

The series does not end with the chemist. The relation of the biologist to the chemist is like that of the chemist to the physicist, or of the physicist to the mathematician. He has to deal with structures elaborately built up of a variety of chemical substances, solid, colloidal and liquid; he can penetrate less deeply into these greater complexities.

The truth is that there is a scale of complexities from mathematics to biology—a scale not involving any gradation of moral or intellectual merit; whichever step the man of science stands on, he can rebuke those on one side of him for neglecting the complicating factors which affect all real phenomena, and those on the other for failing to see as deeply into the broader subjects of their inquiry as he himself does into his simpler problems. The accusation is equally true and equally pointless in each case. What we need to learn is not the weaknesses of our allies, which are very like our own, but their strength; we must discover in what ways they can be most serviceable to us.

To this end we may briefly consider how physics has helped chemistry in the past.

In one sense every chemical statement is also physical; it involves a physical background just as every quantitative statement of whatever kind involves a mathematical background. But apart from this general relation we can distinguish three periods in the history of chemistry as related to physics. From the earliest times when any real chemical theory existed—which for practical purposes means from the promulgation of the atomic theory at the beginning of the nineteenth century—down to about 1885, the chief service of physics to chemistry was the establishment of the existence, and the determination of the relative sizes, of molecules. Avogadro's hypothesis was essentially physical, and although chemists as a whole (Faraday is a marked exception) disregarded it for nearly forty years, they lost heavily by doing so, and it was only when Cannizzaro in the fifties demonstrated its importance to chemistry that a real knowledge of molecular composition, the necessary preliminary to a knowledge of structure, became possible. A little later, in 1874, came the definite physical proof of the soundness of the basis of the chemical molecular weights. These were all founded on the assumption that the molecule of hydrogen contained two atoms. Of this there was no positive evidence; the assumption was generally accepted because it was found to explain the facts; but it always remained possible that the hydrogen molecule contained four atoms, and that the number of atoms in all molecules was twice as great as was supposed. In 1874 Kundt and Warburg measured the ratio of the specific heats of mercury vapor at constant pressure and constant volume, and showed that its molecule could not possibly contain more than one atom. It was already known that there were twice as many atoms in a molecule of hydrogen as in a molecule of mercury, and so the final proof of the truth of the molecular theory was supplied.

For twenty-five years after Cannizzaro's paper the energies of chemists were largely devoted to developing the new theory of chemical structure, and to building up on this foundation the great edifice of organic chemistry. On the inorganic side the recognition of Avogadro's principle led to the assignment of the true atomic weights, and as soon as this had been effected the Periodic Classification necessarily and rapidly followed.

Then came in 1885 the second great application of physics, the introduction of thermodynamics into chemistry. The first investigations were indeed some thirty years earlier, and Willard Gibbs had already (1875–1878) published those far-reaching conclusions which were to prove so fruitful in chemistry and physics in later years. But the main development came from van't Hoff. He applied the methods of thermodynamics, based on the general principles of energy, to a large range of chemical phenomena. The most immediately important application was to the behavior of dilute solutions. He realized the great suitability of osmotic pressure for thermodynamic treatment. By means of an ideal engine precisely similar to the classical heat engine of Carnot, but with a solution separated from the solvent by a partition permeable to the solvent alone, he was able to establish, on the experimental basis of Henry's law of the variation of the solubility of a gas with the pressure, the relation between the molecular concentration and the osmotic pressure, and further the relation of this to more easily measurable properties of the solution, the lowering of the vapor pressure, the rise in the boiling point and the fall in the freezing point. He was also able to give a proof of the law of mass action, which had been established empirically some twenty years before. These discoveries initiated the subject of chemical thermodynamics, which has guided so much of the later developments of the science; and they ultimately led, in the hands of Nernst and others of van't Hoff's successors, to the third law of thermodynamics and the chemical constants, and to those investigations of activity which are still in progress.

Perhaps the most immediately important result of this work was the rise of the theory of electrolytic dissociation. Van't Hoff had shown what was the normal behavior of a solution. Experiment proved that while many solutions behaved as this theory required, those of salts in water did not; and their abnormality was always of the same kind; the salt appeared to form more molecules in the solution than corresponded to its formula. The explanation was given (1887) by Arrhenius, who argued that just as the abnormally low molecular weights indicated by the vapor densities of some gases were assumed, and had been proved, to be due to dissociation, so we must suppose that a salt dissociates in water; and since sodium chloride, for example, can dissociate only into its two atoms, and normal sodium and chlorine atoms can not exist side by side in water, it must form charged ions of the two elements, a conclusion supported by the whole electrical behavior of the solution. The precise form which Arrhenius gave to the theory was, as we now realize, very imperfect; but no one can doubt that by the recognition of a new kind of chemical change, and of a type of molecule peculiarly reactive, he gave an immense impulse to the development of chemistry.

The discoveries of van't Hoff and Arrhenius were immediately followed by two events which are generally taken to mark the birth of physical chemistry as a primary division of chemistry, the call of Ostwald

to Leipzig in 1887, and the foundation in the same year of the *Zeitschrift für physikalische Chemie*. Ostwald was in the very first rank as a teacher, if not quite as an investigator, and he was indefatigable in spreading the light of the new science, which yet was really no new science, but as Nernst says,[2] rather the union of two previously separated sciences. The work of the Leipzig school and their followers was largely along lines that had for many years been open for traffic, but had not been used; it consisted in making more precise the physical background which, as I said, underlies every chemical statement. The physical properties of chemical substances and their solutions, and the conditions of their reaction, were measured in detail, and the whole of chemistry assumed a more quantitative aspect. In organic chemistry the enormous variety of new compounds which it was found possible to prepare, and the wonderful success of the structural theory in classifying them, still gave its students plenty of occupation on the qualitative side; but here too the application of the new ideas to explain the behavior of organic compounds was undertaken by Hantzsch with the most illuminating results, and was extended later with great effect by Dimroth and others.

The most important developments of the new science were, however, on the lines of thermodynamics and of the ionic theory. It is a remarkable sign of the predominance of the thermodynamic aspect at this time that Ostwald actually proposed to abandon the idea of atoms altogether; he conceived that he had provided an alternative explanation of the laws of chemical combination, involving no atomic theory but substituting the concept of "equivalent weight," whose meaning was not subject to discussion. By the irony of fate, this doctrine of Ostwald's was propounded exactly at the time when the physicists began their triumphant attack on the problem of the structure of the atom. Van't Hoff had a truer insight into the fundamental problem of chemistry. He pointed out[3] that all natural phenomena may be looked at from two points of view, the thermodynamical and the molecular or atomistic. The nature of a thermodynamic argument is very peculiar. It is based on the fundamental principles of energy, which are as certain as anything we know in science. It lays down conditions of energy change to which a process must conform, granting certain external conditions, whatever its internal mechanism may be. This has the great advantage that, provided the deduction is carried out correctly, which in the simpler instances is not open to doubt, the conclusions are quite certain, and do not depend on the truth of any theory of the process. But for this very reason it does not enable us to decide between two rival mechanisms, provided they can both give the same energy result. And in particular, it takes no account of the time; the ideal processes of a thermodynamic cycle occur reversibly, that is with an infinitesimal driving force, and hence would in fact require an infinite time. So while thermodynamics tells us what the result will be, it does not tell us how we get there or how long it will take.

Of the immense importance of thermodynamics as a calculus there can be no doubt; it lays down conditions to which every true theory must conform, and thus eliminates many false ones; and it has further the great practical use of enabling us to determine a property which it is difficult to measure directly, by observing some thermodynamically related property which is more accessible, as when we determine the osmotic pressure of a solution by observing the change of its freezing point, or the heat of dissociation of a gas from the change of density with temperature. But it only answers half our question; it does not tell us what the molecules are doing in a chemical process; as Ostwald's argument showed, it does not even involve the assumption that there are any molecules. For the proper development of chemistry, the thermodynamic side must be supplemented by the molecular-mechanical.

At the time of which I am speaking, the latter years of the nineteenth century, this second side of the matter could not be developed in great detail, owing to the scanty knowledge which we had of the molecule. The relative masses of molecules and the number of atoms which they contained were known with accuracy; but for their absolute masses only the roughest approximations were available, and of the structure of the atoms, and the mechanism which holds them together in the molecule, nothing was known at all. The discovery of the electron in 1897 was the first proof that the atom had any parts.

In the year 1900—an easy date to remember—came the greatest revolution that physics has ever known, the discovery of the quantum by Planck; and this marks the beginning of the third period in the relations of physics to chemistry. Up to that time all physics had been based on what we now call the classical mechanics of Galileo and Newton. This theory had arisen from the observation of the motion of visible bodies on the surface of the earth—weights and pendulums—and had then been extended to the planets, and shown to be equally true of their motions. It had sustained the whole triumphant march of physics through the ensuing two centuries. It was universally assumed, and as it seemed with complete justification, that these principles, which had been

[2] Lehrb., 1893, 1st ed.

[3] "Lectures on Theoretical and Physical Chemistry," 1898, Vol. I, p. 12.

shown to apply alike to the motions of pendulums and of stars, were equally applicable to all kinds of matter, down to its smallest particles. But towards the end of the last century difficulties had arisen in applying these principles to certain classes of phenomena, especially to those dealing with the relations of radiation and matter. To give only one example, it could be shown on the classical mechanics that the energy of radiation must pass almost entirely into the shortest waves, so that the most intense radiations of a hot body should be in the far ultra-violet; while experiment showed that for ordinary hot bodies the maximum was in the far infra-red, and that even the light of the sun with a surface temperature of 6,000° has its greatest intensity in the yellow, as any one can see by looking at it.

To meet these difficulties Planck put forward the quantum theory, of which the essence is that the interchange of energy does not take place continuously, but in separate steps or quanta, the size of which is not fixed like that of an atom, but is proportional, for radiation at least, to the frequency of the oscillations or waves of which the energy consists. This theory, the truth of which has been completely established by the subsequent development of physics, leads to a remarkable conclusion. It applies of course to all bodies large or small, but in its practical results it leads to one conclusion for large bodies and another for small. The quantum itself is always, in comparison with quantities of energy that we observe in ordinary life, very minute. Thus of the quanta of yellow sodium light it would take 10^{-16}—ten thousand million million—to heat a milligram of water one degree. It follows that when we are considering masses of matter and quantities of energy such as we can see or handle, the "steps" by which Planck replaced the continuous process of Newton are so small and so numerous as to make no practical difference. Hence for the mechanics of all such "macroscopic" quantities of matter the new theory leads to the same results as the old. This is indeed to be expected; the Newtonian theory has been verified for such bodies, and for them it is true; but for very small bodies, and especially for atoms, the steps become significant, and the theory is not true. This is far from meaning that the new theory is of no practical importance. Our whole lives depend on processes which, although they occur with weighable quantities of matter, really depend on the simultaneous occurrence of an enormous number of atomic interchanges of energy, and these can only be interpreted by means of the quantum theory. It is precisely in chemistry that we have to deal with phenomena of this kind. The first direct evidence of the quantum theory, though of course it was not recognized as such at the time, is Dalton's law of multiple proportions. The "ratio of two small numbers," which we have to introduce in expressing this law, is the fundamental characteristic of the quantum theory. It was no accident, but a basic necessity, that made Ostwald's attempt to eliminate the atom break down when he came up against the laws of multiple and reciprocal proportions.

The recognition of the true mechanics of the atom was a necessary preliminary to any detailed knowledge of atomic structure. The main constituents of the structure had indeed been discovered without the help of the quantum theory, the electron in 1897 and the nucleus in 1911; but their interactions could not be worked out as long as the older mechanics of Newton and Maxwell was used; in fact, on these principles the nuclear model of Rutherford was impossible, and it was only after Bohr had shown how to apply the quantum theory to the atom that further progress could be made. How rapid this progress has been in the last 20 years we all know; it has finally broken down any distinction in subject-matter between physics and chemistry, and the elucidation of molecular structure has now become the task of both sciences.

This brief account of the services which physics has rendered to chemistry in the past may help us to realize the true relation of the sciences to one another. The opposition of extension and intension—the rule that the simpler the problem, the more completely we can solve it—still holds. If we call chemistry molecular physics, we may say that the physicist is applying his more deductive methods to its simpler aspects, while the chemist is simplifying its more complicated phenomena by observation and induction. The practical use of a discussion such as this, which is addressed primarily to chemists and not to physicists, is to get a truer conception of the way in which the chemist should pursue his subject, and of the extent to which he should be influenced by physical conclusions. On the latter point the position is clear; we are bound to make use of any physical weapon that is available for the solution of our problems. On our side we have a duty both to physics and to ourselves. In the first place we have to present to the physicist in a simplified form those questions arising out of our chemical experience which he is best able to solve. The multiplicity of chemical phenomena is so great that only those who have given their whole attention to the subject can really know the facts relevant to a particular chemical question. We have therefore to collect and coordinate the data bearing on the phenomena which are accessible to physical attack. We also have to remember that we chemists are, so to speak, responsible for all chemical compounds. The physicist selects a few compounds peculiarly suitable for his measurements, and acquires de-

tailed knowledge about their structure and behavior. We have to review the whole field of chemistry, and to see how far these conclusions can be extended to chemical substances in general, and if they can not, to find if possible what chemical characteristics limit this application.

At the same time we have to go on with the work of educing general principles out of the great mass of chemical particulars. In the course of this process of simplification it is never possible to proceed very far without forming some idea of the actual mechanism which is at work, or in other words without forming some hypothesis and imagining some model of the molecule. The physicist proceeds in the same way; but his simpler problems, lying nearer to the ideal systems for which the complete dynamics can be worked out, make possible a more detailed theory and a more precise model. This does not mean that they are better than those of the chemist, if by better we mean more suited to the advancing of knowledge; there is a place in the growth of science for both. Every theory and every model is imperfect. As Bohr has pointed out, a model of an atom or molecule is a machine of macroscopic size which is supposed to behave in the same way as an atom or molecule. But such a model, owing to the magnitude of the energies and motions of its parts, will act on the Newtonian laws of mechanics, while the atom is subject to the quantum restrictions. An exact agreement between the model and reality is therefore not to be expected; we can only try to make the differences as small as possible. This is the position of the Bohr model at the present moment. It is built on classical principles, and then a new condition is imposed, forbidding all forms of motion which do not comply with the quantum principles. This new condition is wholly arbitrary, in the sense that it does not follow from the construction of the model; but it is necessary in order to make the model work right.

This model has shown an amazing power of behaving like a real atom; the experimental results can be shown to agree with those predicted even in quite small details. But with the rapid development of atomic physics the model has not been found equal to every demand made upon it. This was partly due to the difficulty of calculating the behavior of such a model in any but its simplest forms; and so far we might hope that the difficulty would be removed by improvements in mathematical analysis. But there were more serious troubles; in certain respects the conclusions derived from the model were shown to be definitely wrong; for example, it represented the hydrogen atom as a disc, while it could be shown experimentally that it was a sphere. This does not necessarily mean that the model is entirely wrong, but only that it is imperfect. In the last few years a new method of attacking atomic structure has been developed, that of wave mechanics. This can hardly be said to involve a model at all; or if it does, it is an elusive form of the Rutherford nuclear atom, in which the stationary states of Bohr are maintained, without their physical meaning being clearly expressed, although it is mathematically defined. But whatever we may think of the new model, the efficacy of the mathematical calculus involved is indisputable; it makes it possible to predict a whole series of properties which were inaccessible by the older method, and which can be verified experimentally. It is obvious that the equations of the new wave mechanics express the truth very closely, and are of immense practical value; and we may hope that as our knowledge increases it will become possible to represent them by a definite model—perhaps some modification of the Bohr model—which will bring the structure more clearly before us.

I have discussed the atomic model at some length, partly because of its intrinsic interest, but largely because an understanding of the conditions and limitations of a physical theory will help us to grasp those of a chemical theory. A chemical theory, dealing with more complicated phenomena, is less accessible to mechanical treatment. It takes account in the first instance of properties which can not be measured quantitatively, but which are clearly shown to exist. It adopts some terminology to express these, without at first making any exact assumptions as to their physical meaning. This after all is what physics has done with the quantum; we don't even know what the quantum limitation really means, although we know what effect it produces. As an example of a chemical theory consider the theory of structural chemistry. This in its original form assumed the existence of linkages between the atoms in a molecule, the nature of which it did not pretend to discuss, though it could make accurate statements as to their number, and as to the order in which the atoms were linked. It was capable of predicting the composition and many of the properties of the substances formed in innumerable organic reactions, and of consistent application to hundreds of thousands of organic compounds. "Chemists," as Helmholtz[4] said in 1891, "must be allowed to form hypotheses after their fashion, since the whole extraordinarily comprehensive system of organic chemistry has developed in the most irrational manner, always linked with sensory images, which could not possibly be legitimate in the form in which they are represented." A direct result of these "sensory images," that is, of the simple model of atoms joined by links of an unspecified physical

[4] Koenigsberger's "Life," English ed., p. 340.

nature, was the further development begun by van't Hoff, when he extended these ideas to three dimensions, and opened up the new field of stereochemistry. As knowledge increased, new relations were discovered in the behavior of these links. Baeyer in his strain theory assumed that two links of one carbon atom had a "natural" inclination to one another, that given by the tetrahedral model, and that any departure from this involved a proportionate degree of instability in the molecule. This conclusion could not be deduced from the nature of the link, because that nature had not been physically defined; but it was justified by the fact that its consequences agreed with experiment.

During the further study of the reactions of organic compounds, it became possible to classify to some extent the effects which are exerted on the reactivity of certain atomic groups by other atoms or groups present in the same molecule. To express these conclusions new symbols were adopted—plus and minus signs, or thick and thin bonds. All these developments were perfectly legitimate if they made it easier to coordinate the results of experiment. No assumption had been made as to the physical meaning of the valency bond, and the new theories only implied that *this force of unknown character is found experimentally* to be capable of certain modifications, which are expressed by the new symbols. This is typical of a chemical as opposed to a physical theory; it arrives by induction from experiment at a series of relations between the structures of molecules and their behavior, and shows that these can be simply explained by a small number of assumptions as to the forces between the atoms; but it makes no statement as to the physical meaning of these forces and their modifications.

At the time when these theories of reactivity in organic compounds were being developed, the physicists had arrived at a theory expressing the valency forces in terms of electrons; in particular G. N. Lewis had shown that the non-ionized links, with which the organic chemists were mainly concerned, could be ascribed to the sharing of the valency electrons, two to each link, between the atoms. This theory was itself in some degree symbolic; no one knew precisely what was meant by sharing—we are only now, 15 years later, beginning to learn what it means—but it was possible on the Bohr model to get some general idea how it might happen, and as physicists were by this time able to count exactly the number of electrons in the atom and to determine what groups of electrons were stable, the Lewis theory could be extended very widely; and it was found to give satisfactory results, and to involve no assumptions as to the physical nature and behavior of electrons incompatible with physical experience.

It was quite evident that the explanation of the differences which the organic chemists had detected in the links must ultimately be found in the behavior of the valency electrons; and the organic chemists hastened to look for it there. But at this point we come upon a difficulty. As long as the chemist confines himself to his symbolic representations, he can do what he likes with them, so long as what he does helps him to classify and coordinate his ideas. But as soon as he claims to give them a physical meaning, he must recognize all the implications of a physical statement. Links or bonds may be strained, or thickened, or imperfectly saturated, or classified into primary and subsidiary, and the atoms they join may have a positive or a negative character, because these words correspond to real differences in behavior, and therefore to some change in the forces between the atoms, which we may hope to explain when we know what these forces are. But electrons must behave in certain ascertained ways, and the distribution of positive and negative electricity in a molecule is subject to physical laws and measurable by physical means. It can not be denied that this requirement has sometimes been overlooked. It was said of one well-known theory of molecular structure, which did very good service in its day, that the author's electrons "had so few of the known properties of electrons that it is not immediately clear why they are called electrons at all"; and the same might be said with equal truth of some other theories.

Thus the transition from the chemical to the physical theory needs care. The ultimate object of the chemist is to express his conclusions in physical terms, but he must remember, if he tries to do this, that these terms have already a very elaborate and precise connotation; every concept which he uses involves a series of definitely established properties. That in fact is why it is so important to be able to use them. But it is essential to use them rightly. The chemist must not employ the language of physics unless he is willing to accept its laws. Within these laws a certain latitude of interpretation is left to him, and some tentative physical suggestions may be put forward unsupported by physical evidence, provided the physical evidence does not contradict them. On this last point no exceptions are allowed. The chemist must resist the temptation to make his own physics; if he does, it will be bad physics—just as the physicist has sometimes been tempted to make his own chemistry, and then it was bad chemistry.

If these points are clearly realized, the prospects of progress in chemistry are far more favorable now than they have ever been. The ultimate problem of the establishment of the relation between molecular structure and properties is open to attack from both

sides, and these attacks are now converging. We have found that the mechanics of the atom is different in many ways from that of large bodies, and we—or they—have found what the mechanics of the atom is, or at any rate how its results can be calculated. Physics has already told us the "empirical formulae" of the atoms, the number of electrons which they contain and their dispositions. It has given us a mechanism of atomic linkage. It has provided us with methods of measuring many of the characteristic properties of the links between atoms, the distance between the atoms, the relative positions in space, the way in which the electrons are shared between the atoms, the work required for their separation. The problems before us are far too complicated to be solved by physicist alone—by deductive reasoning founded on experiments with a few selected compounds. But much of the information we need he has shown us how to obtain; if we cooperate heartily he will provide us with more; and in this way our theories can be tested and amended by physical measurements and physical reasoning at every step. All that is needed is a proper mutual understanding and good-will.

EDWARD W. MORLEY, CHEMIST, INVESTIGATOR, TEACHER

(Some Personal Notes)

By CHARLES FRANKLIN THWING

PRESIDENT EMERITUS OF WESTERN RESERVE UNIVERSITY

OF the many scholars, scientific, classical, linguistic, historical, philosophic, sociological, who were my college associates for more than thirty years, none was more learned, more illustrious, more devoted, than Morley.

Edward Williams Morley was a child of the manse. He was also a graduate of Andover Theological Seminary. The principles underlying his religious parentage and training were the fundamental and permanent elements of his character. But early in his service as a minister (in Twinsburg, Ohio), he was offered a professorship in Western Reserve College in the neighboring town of Hudson. For in this service he had proved that his interest was rather scientific than theological or clerical. The foundation bore the traditional title of "Natural History and Chemistry." The professorship under this and other titles he held until his retirement in the year 1906. His teaching covered forty years.

Morley united, as not many college professors do unite, great power as a teacher with equally great power as an investigator. His power as a teacher was primarily found in his knowledge, and quite as fundamentally in his devotion to the individual student. His power as an investigator is, of course, illustrated in his devotion to his many and diverse researches. His power as a teacher lives, and lives as long as do the lives of the hundreds of students whom he taught, and to whom he gave intellectual quickening. His work as an investigator relates to at least two fields of nature. In one of these fields his work is completed and is done apparently unto conclusiveness. This work has given him place among the greatest of scientists. In the other field his work still progresses. The first field relates, as says his successor Professor O. F. Tower, to "The densities of oxygen and hydrogen and the ratio in which they combine."[1] The field in which the work is still going on is the field associated with the name of Einstein. In the second field he collaborated with Professor A. A. Michelson "In developing the interferometer, an instrument for measuring lengths in terms of the wave-length of light. They used this instrument to determine the relative motion of the earth and the luminiferous ether."[2] With Professor W. A. Rogers he worked in measuring the expansion of metallic bars; and also with Professor Dayton C. Miller, of the Case School of Applied Science, he experimented upon the "velocity of light in a magnetic field." In all these and other experiments he became associated with his friend, Charles F. Brush, and with Elias Loomis, of Yale, who, long before Morley, was a professor in Western Reserve College. The Michelson-Morley cooperation and the earlier Loomis-Morley cooperation are among the outstanding partnerships in scientific research. Great in his discoveries and inventions, Morley was also great in his associates, and they also were made great through and in him.

These facts both prove and illustrate the breadth of Morley's mind. His interests and devotions were many, his chief interest however lay in the field of the physical sciences. His intellect was at once comprehensive and concentrated. He recognized the differences between a vocation and an avocation. His avocations, however, were several. He knew and loved music. Playing the organ at the chapel service was one of his minor services given to the college at Hud-

[1] O. F. Tower, "Edward Williams Morley," *Western Reserve University Bulletin*, August, 1923, p. 59.

[2] *Ibid.*, p. 61.

son. He learned Russian in order to read the Russian chemical and other journals. But his vocation was commanding, persistent, unrelenting.

The great and lasting results Morley achieved arose from several causes and conditions. Among them were his intellectual alertness, his comprehensiveness, his patience, his laboriousness, and, be it added, his skill in manipulation. His reasoning seemed to be a series of intuitions. Conclusions followed swiftly on insight. Yet, though being the master of immediate intellectual processes, he was also patient. He revised and re-revised his methods, measures and movements; tested and retested his conclusions. Like Pasteur, he examined all hypotheses contrary or similar. All possibilities of error, either personal or of conditions, he sought to remove. More strongly than many scientists he was able to say, "This is the truth: I can no other." It was also well that Morley's power was not simply of intellect and of will: he had great skill with his hands. In the poverty of the college he was largely his own assistant, and the maker of his own apparatus. He was, for instance, a skilled glass-blower, a skill of the utmost value in his long experimenting process in determining atomic weights. Gifted with all these powers he used them to the utmost. He was among the hardest of all workers ever known to me. He gave full service as a teacher till the trustees of the college offered him complete liberty respecting his interpretation of his duties, a liberty of which he did not fully avail himself. Fourteen hours a day was a minimum of the time spent at his tasks. He toiled to the limits of strength. His wife has said to me that it was not unusual for her at the close of the day to watch for him coming home, questioning whether he might not have fainted on the way. A speedometer which he sometimes used proved that in his walking to and fro, up and down, in the building wherein were his rooms, he frequently walked in a single day no less than twenty miles. Scientists are indeed hard workers, some would say the hardest; and no one of them was a harder worker than Morley.

As a scientist Morley's place is secure. It is by common consent among the highest. In the unique worth of this service I of all men should not pass over his worth as a teacher. For hundreds if not thousands of students rise up to bless him. Formally he taught chemistry, but he also taught every other subject. He especially taught English, and the oral use of our English speech. Precise himself in language, he demanded correctness and precision of all students. Oral slovenliness he abominated. Many a student have I heard say, "Morley taught me English as no English teacher." Devoted to the students in ways both specific and general, he required of them an equal devotion to the subject of study. No tolerance had he for the shirker. Faithlessness easily stirred his indignation. He was profane without words. He could not suffer fools, either intellectual or moral. They quickened his abhorrence. But to the student highest, earnest, alert, laborious, he was devoted. His devotion to truth, as I have intimated, was no less intense. From these two foci of devotion to truth and of laboriousness are swiftly and easily drawn the ellipse of his achieving life and rich character.

I can not compare Morley to Pasteur in respect to the directness and beneficences of his service to humanity; but I can compare him to Pasteur in respect to the fundamental elements of scientific research. I can not compare him to Darwin, for Darwin was not a teacher; but I can compare him to Darwin in respect to the intuitive vision, the comprehensiveness of understanding, the persistent patience, the humility of spirit, the prolonged and sober enthusiasm in which he pursued his researches.

OBITUARY

RECENT DEATHS

DR. GEORGE P. DREYER, professor and head of the department of physiology in the College of Medicine of the University of Illinois, Chicago, since 1900, died on February 27, at the age of sixty-five years. Professor Dreyer is known for the discovery of the secretory nerves of the suprarenal glands, and for his work on blood proteids and differential respiration.

CHARLES GLASER, well known for his researches in analytical and technological chemistry, died on February 17, in Baltimore, at the age of seventy-six years.

DR. EARL DOUGLASS, geologist and paleontologist, in charge of the dinosaur collections of the University of Utah, died on January 14, at the age of sixty-nine years.

SIR RICHARD CARNAC TEMPLE, Orientalist, died in Switzerland on March 6, at the age of eighty years. He was a former president of the anthropological section of the British Association for the Advancement of Science and had written many works on the East. Sir Richard was a member of numerous British and American scientific groups, including the Smithsonian Institution in Washington, the American Geographical Society, the American Philosophical Society and the Numismatic Society of Philadelphia.

Nature reports the death of Professor J. S. Dun-

kerly, Beyer professor of zoology in the University of Manchester, known especially for his researches on the Protozoa, on February 11, aged forty-nine years; of the Honorable Sir Charles Parsons, whose name is associated particularly with the development of the steam turbine, on February 12, and of Mr. W. G. Robson, lecturer in natural philosophy in the University of St. Andrews, on February 16.

MEMORIALS

THE centenary of the Harveian Society of London is to be celebrated in June. According to the program, as printed in *The British Medical Journal*, the opening meeting, at which an oration will be delivered by Dr. Raymond Crawfurd, will be held on June 11 at St. Bartholomew's Hospital, with Sir Thomas Horder, Bt., in the chair. It is proposed to ask delegates from all the medical societies in London and the surrounding districts; after the oration tea will be served and an exhibition of Harvey relics opened. On June 12 the Buckston Browne dinner will be held at the Grocers' Hall, with H. R. H. Prince Arthur of Connaught as the principal guest. On June 13 there will be a pilgrimage to Hempstead Church, Essex, where William Harvey is buried. A short service, conducted by the Bishop of Colchester, is to be held at 12 noon, and on the return journey it is proposed to visit Rolls Park, Chigwell, where Harvey lived at one time. The present owner, Lady Lloyd, has very kindly consented to entertain any members and friends of the society. After tea Sir D'Arcy Power will give a short address on William Harvey's association with Rolls Park.

SCIENTIFIC EVENTS

THE CONSTITUTION OF THE ROYAL COLLEGE OF SURGEONS

AN article in the *Journal* of the American Medical Association states that there are about 2,000 fellows of the Royal College of Surgeons and 18,000 members. The fellows pass a higher examination in surgery and are designated F.R.C.S. They are surgeons in the full sense of the term and generally are members of hospital staffs. Many of them practice only surgery or one of its special branches. They include all who are eminent in English surgery. The members pass a lower examination, devised for those who will engage in general practice, and are designated M.R.C.S. They usually practice surgery only in a minor form, their working being mainly medical. The college is governed by the council, which is elected from and by the fellows. The only occasion on which the members have an opportunity to say anything as to the government of the college is the annual meeting of members and fellows, when they can bring forward resolutions, which are submitted to the council. At this meeting they have for forty-two years passed a resolution that the members should be given the power to elect representatives on the council. This the council has always refused. At the 1929 meeting the members were twitted by the president, Lord Moynihan, with the fact that the number who attended was small (about fifty) and that he always saw the same faces. There was therefore no evidence that representation was desired by the members at large. At the 1930 meeting, which recently took place, the members demanding representation replied by bringing forward the result of a poll taken by postcard in Great Britain and the Irish Free State. This showed that for 12,766 cards sent out 6,832 votes were received in favor of representation and only 156 against. At the meeting, much was made of this; the argument was the "justice" of the claim for representation of nine tenths of the college roll and the need to protect the members against unqualified practitioners. When a vote was taken, the request for representation was carried by 43 votes to 1. The president said in reply that the question of representation of the members had always been regarded by the council as of the gravest importance and that a special meeting would be held to consider the resolution. At this meeting the council adopted the following resolution:

> The main functions of the college are to promote and encourage the art and science of surgery for the common weal, and for this purpose to conduct the examinations of the college and to maintain the great museum and library placed under its care. In carrying out these functions the council organizes lectures and demonstrations, provides facilities for and encourages research, fosters social intercourse and the amenities of the profession, and in every way possible renders the college an instrument for the advancement of surgery in its widest sense, not only for the benefit of the members and fellows, but the whole profession throughout the empire. In the opinion of the council these functions are well carried out under the present constitution; after further and prolonged deliberation the council has therefore decided that it is not desirable to alter the constitution of the college by providing for the direct and separate representation of members of the college upon the council. The decision of the council is in conformity with the opinion expressed three years ago by the body of fellows of the college who are the electorate.

THE STATE PARKS AND FORESTS OF NEW JERSEY

IN a report submitted to the New Jersey Legislature on March 2 and reported in the *New York Times*,

the State Board of Conservation and Development recommended a ten-year program to cost about $7,500,000 for acquisition of a system of state parks and forests. Request was made for an appropriation of $730,000 for such work in the coming fiscal year.

New Jersey has been backward compared with many other states, in the acquisition of such lands. The board states that "the unrestricted use of even the wilderness areas for outdoor recreation is rapidly passing."

For the money asked, it was estimated that 124,500 acres could be acquired for new state forests and parks, 765 acres for seashore parks and 216,167 acres for additions to existing parks and forests.

Within the area north of Trenton it was recommended that four new state forests and parks be established, one of which would comprise 5,000 acres between Rocky Hill and Monmouth Junction. Two of the others would be in Hunterdon County, where the purchase of a wooded area of 2,500 acres just west of Whitehouse and 10,000 acres between West Portal and the Delaware River was suggested. The fourth would embrace 5,000 acres in Bergen and Passaic Counties.

Existing state parks and forests in the same area would be expanded under the board's plan. Holdings on the Kittatinny Mountains in Sussex and Warren Counties would be increased from 21,000 to 60,000 acres, and the Jeny Jump Mountain Forest, which consists of 323 acres with approximately 1,000 more under contract for purchase, would be extended to a minimum of 8,000 acres. To the 519 acres of the Swartswood State Park 200 would be added and 100 acres acquired to round out the holdings at Lake Hopatcong. The Hacklebarney State Forest in Morris County would be increased from 123 to 1,200 acres.

The Voorhees State Park, near High Bridge, would be expanded under the plan to 750 acres. The Washington Crossing Park would also be extended.

Establishment of five seashore parks was recommended by the board. These would include 30 acres of beach, just north of Seaside Heights, 100 acres south of Seaside Park, 35 acres in the vicinity of Barnegat Inlet, where the state now owns the land on which the historic Barnegat Light is located; 500 acres to be known as Harvey Cedars Park, which would be below Barnegat, and 100 acres extending from the sea to the bay below Beach Haven.

In the area below Trenton and South Amboy three new parks and forests would be developed and the areas of existing reservations would be extended.

FEDERAL LEGISLATION

SCIENCE SERVICE reports that authorization for sufficient funds to allow this country to participate in the Second Polar Year in 1932–33 and in the International Geological Congress in 1932, failed to pass the House in the closing hours of the session because of objections to consideration on the part of certain members.

A program for soil erosion work and technical study of conservation of rainfall for the Bureau of Agricultural Engineering passed the Senate, but failed of passage in the House.

The oleomargarin law was amended so as to put all yellow colored margarins under the ten cent per pound tax previously applied only to those margarins artificially colored. The new regulations are to be applied because of the recent development of natural colored palm oil margarin.

The maternity and infancy aid act passed both Senate and House, but with such differences that the conference report, though accepted by the House, did not come to a vote in the Senate. The House added to the Senate bill's authorization of such work by the U. S. Children's Bureau, an amendment providing for the setting up of county rural health units to be administered by the U. S. Public Health Service.

The Bureau of Plant Industry and the U. S. Forest Service were provided by this congress with a large fund for fighting white pine blister rust in western forests. The total amount in various bills ran well over $700,000. In the national forests alone there are five billion feet of merchantable white pine timber worth $25,000,000, in addition to one million acres of young white pine worth about $180 per acre. On privately owned lands there is also an immense acreage which would be a great loss if infected with the rapidly spreading blister rust. Currant and gooseberry bushes spread the disease. The Bureau of Plant Industry will cooperate with states and individual timber owners in the work of eradication this year.

The Bureau of Mines was authorized to establish a Mining Experiment Station at College Park, Maryland. A bill authorizing the collection of crime statistics passed both houses and was signed by the President.

Isle Royale in Lake Superior was made a national park, but the Everglades National Park bill failed to get through the House, though it passed the Senate.

A memorial in Washington to the late Stephen T. Mather, former head of the U. S. National Park Service, was authorized. The Stephen T. Mather Appreciation Committee has long had in mind several methods of preserving to the nation's memory the work of the father of the national park system. The memorial in Washington is only one of these. Another plan is to erect in each of the 23 national parks and 33 national monuments a bronze plaque decorated with a bas relief bust of Mather, an epitome to his work, and a sentence or two from his writings about national parks.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

At its meeting in February the National Research Council's Committee on Grants-in-Aid made grants for the support of research as follows:

To Dr. R. G. Aitken, associate director, Lick Observatory, determination of the value of the solar parallax; Margaret Harwood, director, Maria Mitchell Observatory, the size and distance of the Scutum Star Cloud; C. E. Mendenhall, professor of physics, University of Wisconsin, photoelectric characteristics of metals; Linus Pauling, associate professor of theoretical chemistry, California Institute of Technology, the determination of electron distribution in various crystals.

John C. Aston, instructor in physical chemistry, Pennsylvania State College, the heat capacities of simple organic nitrogen compounds; H. L. Johnston, assistant professor of chemistry, Ohio State University, determination of the heat capacity curves of simple gases; A. L. Robinson, assistant professor of chemistry, University of Pittsburgh, thermo-chemical properties of electrolyte solutions.

E. M. Kindle, chief of the division of paleontology, Geological Survey of Canada, a bibliographic index of North American Devonian fossils, and an illustrated catalogue of types of North American Devonian fossils; Edward L. Troxell, professor of geology, Trinity College, vertebrate fossils from the Wasatch or Wind River formations in Wyoming.

C. Sidney Burwell, professor of medicine, and Glenn E. Cullen, professor of biochemistry, Vanderbilt University School of Medicine, the abnormal physiology and chemistry of congestive heart failure; David M. Greenberg, assistant professor of biochemistry, University of California, the factors involved in the delayed blood coagulation of jaundice, and the ultrafiltration of diffusible ions from systems containing electrically charged colloids; Robert Hegner, director, department of protozoology, Johns Hopkins University, the occurrence of amoebiasis in Panama.

R. A. Brink, associate professor of genetics, University of Wisconsin, partial sterility in maize; Henry Federighi, assistant professor of biology, Antioch College, the effect of temperature on the heart rhythm of the caddice fly larva; Hope Hibbard, professor of zoology, Oberlin College, cytological studies on the silk gland and the developing gonads of *Bombyx mori;* Alfred C. Kinsey, professor of zoology, Indiana University, the gall wasps (Cynipidae) of Mexico; Wallace J. Robbins, professor of botany and dean of the graduate school, University of Missouri, the cultivation of the isolated primary meristem of higher plants in sterile media.

Edward F. Castetter, professor and head of department of biology, University of New Mexico, the ethno-biology of the Indians of the southwestern United States; Fay-Cooper Cole, chairman, department of anthropology, University of Chicago, archeological investigations in Chihuahua, Mexico; Karl M. Dallenbach, assistant professor of psychology, Cornell University, nerve regeneration; Laurence Foster, instructor, Stowe Teachers College, racial mixture between Negro, Indian and white stock in Maryland and Delaware; William R. Morse, dean of the College of Medicine and Dentistry, West China Union University, the physical anthropology of the Western Chinese and neighboring peoples; Edward C. Tolman, professor of psychology, University of California, the inheritance of maze-learning ability in rats.

Vernon Kellogg,
Permanent Secretary, National Research Council

SCIENTIFIC NOTES AND NEWS

Dr. Albert Einstein sailed for Germany on March 5, after two months' residence at the California Institute of Technology. Before leaving he expressed his intention to return in November. At a dinner in honor of Dr. Einstein, given in New York the evening before he sailed by American Zionists in the interest of the Palestine Foundation Fund, the following message from President Hoover was read: "I am glad of this opportunity to express my admiration of your distinguished service to mankind through your scientific researches and my hope that your visit to the United States has been as satisfying to you as it has been gratifying to the American people."

Madame Curie has been awarded the Cameron Prize of the University of Edinburgh for 1931, in recognition of the important therapeutic advances that have been made in recent years as a result of her discovery of radium.

A portrait of Dr. Samuel W. Stratton, chairman of the corporation of the Massachusetts Institute of Technology, was presented to the Bureau of Standards on March 7, on the occasion of the thirtieth anniversary of its founding. Dr. Stratton was the founder and first director of the bureau. The ceremonies were conducted by Dr. George K. Burgess, the present director of the bureau, and the portrait, which was painted by Margaret Fitzhugh Browne, was presented by Mr. Henry A. Wise Wood, of New York City, in appreciation of the invaluable services rendered American industry by Dr. Stratton and the bureau.

At a recent meeting of the New York State Horti-

cultural Society a resolution was adopted requesting the state legislature to name the new laboratory building now being erected on the grounds of the State Experiment Station at Geneva "Hedrick Hall" in honor of Dr. U. P. Hedrick, director of the station.

PROFESSOR A. H. JOY, of the Mount Wilson Observatory, was elected president of the Astronomical Society of the Pacific, at the annual meeting on January 31.

PROFESSOR DOUGLAS JOHNSON, of Columbia University, has been elected an honorary member of the Geographical Society of Belgrade in recognition of his work on the morphology of coasts.

DR. HERBERT S. JACKSON, head of the department of botany in the Purdue Agricultural Experiment Station, resigned on January 1, in order to accept the position of professor of mycology and cryptogamic botany in the University of Toronto. During his time at Purdue University he has been connected with the Bureau of Plant Industry at Washington in connection with cooperative investigations on leaf rusts of cereals.

THE University Court of St. Andrews University has appointed Dr. Daniel Fowler Cappell, at present lecturer in pathological histology in the University of Glasgow, to be professor of pathology in the University of St. Andrews, in succession to Professor Sutherland, who retired at the end of the last academical year.

DR. SVEIN ROSSELAND, who has recently returned to Norway after a year's work at Harvard University, will organize an institute in Oslo for theoretical astronomy. The Storthing has granted special facilities to Dr. Rosseland, with funds for a building and endowment.

DR. HOLGER THIELE, of the astronomical department of the University of California, has been appointed by Northwestern University research associate at Dearborn Observatory for a number of months. He is assisting the other members of the staff in various phases of the study of Eros.

DR. C. O. EDDY, associate entomologist of the South Carolina Experiment Station, has been appointed to the research staff of the Experiment Station of the University of Kentucky. He will be associated with Professor W. A. Price, state entomologist and head of the department of entomology and botany of the Experiment Station and College of Agriculture. For the next few months he will study the oriental fruit moth and codling moth in orchards in western Kentucky.

DR. JOHN E. GRAF, assistant chief of the Bureau of Entomology, U. S. Department of Agriculture, resigned on March 5, to become assistant director of the National Museum. Dr. Graf has been connected with the Department of Agriculture for twenty years. The position in the museum has been newly created under Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution.

DR. EVERETT P. PARTRIDGE, of Ann Arbor, Michigan, has been appointed supervising engineer of the Non-Metallic Minerals Experiment Station of the U. S. Bureau of Mines at New Brunswick, New Jersey, and Harold W. Robbins, of Chicago, has been appointed editor for the bureau. Dr. Partridge, who is associate editor of *Industrial and Engineering Chemistry*, succeeds Dr. H. H. Storch, who will take charge of the section of physical chemistry at the Pittsburgh Experiment Station of the bureau. The chief project now in progress at the Non-Metallic Minerals Experiment Station is a study of methods for producing potash salts from such minerals as polyhalite found in New Mexico and Texas, leucite in Wyoming, and greensand in New Jersey. Work has been done on this project by Dr. Storch and his associates during the past two years, and will be continued and carried into a small-scale chemical engineering stage under the direction of Dr. Partridge. Mr. Robbins's work as editor involves editorial supervision of the publications of the Bureau of Mines, which publishes annually several hundred reports. He succeeds Mr. Frederick W. Horton, transferred to the bureau's mining division for the conduct of research in the mining of non-metallic minerals.

DR. H. J. K. AHLMANN, docent in geography at Upsala, has chartered the polar ship *Quest* for seventy-five days in the coming summer to enable a Swedish-Norwegian expedition to map White Island and inspect the site of Andrée's camp. The expedition is planned to leave Tromsö on June 25.

DR. LECOMTE DU NOÜY, head of the department of biophysics at the Pasteur Institute, Paris, will pay a visit to the United States during the month of April. He will be accompanied by Mrs. Lecomte du Noüy, who is in charge of the Tissue Culture Laboratory in his department. Dr. du Noüy, who was an associate member of the Rockefeller Institute for many years, will stay in New York and study the organization of the tissue culture department of Dr. Carrel at the institute.

DR. ARTHUR J. TIEJE, chairman of the department of geology at the University of Southern California and now on sabbatical leave at the University of Oklahoma to study methods of correlation in the mid-continent oil fields, will again have charge of the summer session courses in geology at Columbia University.

PROFESSOR AND MRS. CLAUDE E. O'NEAL, of Ohio Wesleyan University, are taking a trip into the southern states during which Dr. O'Neal will make a study of the vegetation of that section of the country and gather a collection of southern plants, particularly mosses, which he desires to add to the herbarium of the department of botany at the university. Dr. O'Neal, who has been a member of the department of botany for the past eighteen years, has been granted a leave of absence to engage in this research. The Great Smoky Mountains will be the first object of his explorations and he will later visit Georgia and Florida.

DR. H. J. CONN, chief in research in soil bacteriology at the State Experiment Station at Geneva, New York, has been granted six months' leave, beginning on April 1.

DR. ARTHUR H. COMPTON, professor of physics at the University of Chicago, will give a series of lectures at the College of the City of New York on March 23, 24, 25, 26 and 27, at 8:45 in the evenings. The title of the series is "The Nature of Things."

THE Bacon Lectures of the College of Medicine, University of Illinois, will be given on March 31 and April 1 by Professor Herbert A. Evans, of the University of California. The subjects will be: "The Hormones of the Hypophysis" and "The Relation of the Hypophysis to the Reproductive System."

PROFESSOR W. D. SMITH, of the University of Oregon, gave the annual Sigma Xi lecture before the joint societies of the University of Oregon and the Oregon State College on February 24 at Corvallis. The title of the lecture was "High Lights of the Geography and Geology of South America."

DR. ROBERT W. HEGNER, professor of protozoology and head of the department of medical zoology at the Johns Hopkins University, gave the following lectures at the University of Michigan on February 19 and 20, under the auspices of the department of zoology: "The Invisible Fauna of the Human Body," "Host Parasite Relations among Protozoa," and "Transmission and Host Parasite Specificity among Protozoa."

DR. S. A. MITCHELL, director of the Leander McCormick Observatory of the University of Virginia, will give the second Stuart McGuire Lecture at the Medical College of Virginia, Richmond, on March 25. His subject will be "Eclipse Hunting in the South Seas." The Stuart McGuire Lecture was established a year ago in recognition of the services of Dr. Stuart McGuire to the college, to medical education and to surgery.

PROFESSOR ERNEST E. JUST, head of the department of zoology of Howard University, delivered two lectures under the auspices of the department of zoology at Oberlin College on February 26 and 27, with titles as follows: "Attempts at a Physico-Chemical Explanation of Fertilization" and "The Biology of Fertilization as a Basis for a Theory."

DR. JAMES B. HERRICK, of the University of Chicago, will deliver the sixth Harvey Society Lecture at the New York Academy of Medicine, on Thursday, March 19. His subject will be "The Coronary Artery in Health and Disease."

THE rôle of the biological sciences in modern life was the subject of four lectures given during the winter quarter at the University of Minnesota, under the auspices of Sigma Xi. Dr. Ross A. Gortner, professor and head of the department of agricultural biochemistry, gave the first lecture on "Biochemistry and the World To-day"; Dr. W. P. Larson, professor and head of the department of bacteriology, spoke on "Micro-organisms and Daily Life"; Dr. W. A. Riley, professor and head of the department of entomology, on "Warfare between Man and the Insect Kingdom," and Dr. Florence L. Goodenough, professor of child welfare, on "Child Development and the Coming Generation."

DR. EGON S. PEARSON, of the biometric laboratory of the University of London, will lecture on mathematical statistics during the coming summer session from June 8 to July 16 at the University of Iowa.

DR. WILHELM BLASCHKE, director of the mathematical seminar of the University of Hamburg, is James Speyer visiting professor of mathematics at the Johns Hopkins University from March 2 to May 8. He lectures four hours weekly on "Topological Questions in Differential Geometry" and is also available for consultation by students.

AT a meeting in London of the Royal Microscopical Society on February 18, Dr. Robert Chambers, research professor of biology and chemistry and chairman of the department at the Washington Square College of New York University, spoke on "The Nature of the Living Cell," with demonstrations by micro-dissection, micro-injection and cinematograph.

THE twenty-third Dutch Congress of Natural Science and Medicine will be held at Delft from April 7 to 9.

WE learn from the *Journal* of the American Association that the fifteenth annual clinical session of the American College of Physicians will be held in Baltimore from March 23 to 27, with an additional day in Washington, D. C., on March 28. Symposiums on gastro-intestinal disease, heart disease, endocrine dis-

orders, anemia and questions of public health, medical practice and medical economics are on the program in addition to general sessions devoted to varied topics. Special clinics and demonstrations at the Johns Hopkins University School of Medicine, the University of Maryland School of Medicine, and various Baltimore hospitals are to be given each afternoon of the meeting, from Tuesday to Friday, inclusive. Features of the Washington program are lectures at the U. S. Naval Medical School and at St. Elizabeth's Hospital; clinics and demonstrations at George Washington University School of Medicine, Georgetown University School of Medicine, Mt. Alto Hospital and Children's Hospital; demonstrations of arthritis and syphilis from the anthropological collections of the Smithsonian Institution, and visits to Walter Reed General Hospital, the Army Medical Library and the Army Medical Museum. Among speakers who will present papers are Drs. William S. Thayer, Warfield T. Longcope and Lewellys F. Barker, Baltimore; Henry A. Christian, George R. Minot and Frank H. Lahey, Boston; Ray M. Balyeat, Oklahoma City; Cyrus C. Sturgis, Ann Arbor, Mich.; Gabriel Tucker, Philadelphia; George E. Follansbee, Cleveland, and David P. Barr, St. Louis.

DEEDS conveying over 840 acres in the northern section of Durham County to North Carolina State College were filed January 28 by George Watts Hill, '22, of Durham. The property will be used by the Forestry School, and is considered one of the most important gifts ever made to the forestry division.

THE Polytechnic Institute of Brooklyn has received the sum of $250,000 in payment of the legacy left to the Institute by the late Dr. William H. Nichols, chairman of the Board of the Allied Chemical and Dye Corporation. Dr. Nichols, who was one of the founders of the American Chemical Society, was a graduate of the Polytechnic Institute in the class of 1868 and was for forty years a trustee of the corporation, serving as its chairman for eighteen years.

DISCUSSION

MORE EVIDENCE OF MAMMOTHS IN THE HIGH MOUNTAINS OF COLORADO

IN SCIENCE of July 18, 1930, the writer called attention to evidence of mammoths and giant bison in the high mountains of southern Colorado. Since writing this note, more evidence of a similar character has come to light in other localities, and extending this range nearly to the northern end of Colorado, along the high front ranges.

A ranchman living near Canon City, Colorado, showed the writer a fairly complete upper molar of a mammoth, which agreed closely with the typical *Parelephas columbi* in having 19 plates, and similar structure. The tooth had originally been well preserved when found; but exposure and lack of proper care had so softened it that it was crumbling, and nearly ready to fall to pieces when examined. The owner, who did not care to part with it, stated that while working in a road cut, "a few miles out of Cripple Creek" on the little used road leading down Phantom Canon to Canon City, and "near the top of the divide," in an old gravel bed far above present wash, he had dug out this tooth. The spot he described is stated to be at an elevation of "above 8,000 feet." He said that he also found at the same spot some big broken bones, some inches in diameter; but that these had soon gone to pieces after he took them out. He did not know that the specimen I examined was a tooth, but had thought that it was a "queer rock formation"; and as it was found near a famous gold locality, he had saved it, not knowing what it might "indicate"!

A second, broken tooth, apparently the same species, which had been found by a local workman in South Park, Colorado, was carefully examined. It was stated that this tooth was dug out of a gravel bed, near the lower end of South Park; and that the gravel lay at this spot on "a sort of shale" in which had been found "fossils that looked like fish." From other sources I have heard from time to time of large fossil bones occasionally found in South Park, of such a size as to suggest mammoth. This tooth which I saw in South Park, near where it was said to have been found, would seem to confirm the occurrence definitely.

A third specimen, also in the hands of a workman, consisting of four plates from a freshly broken mammoth molar, which was, as nearly as could be told from such a fragment, of the same type as the foregoing, was shown to me by its finder, who reported obtaining it from gravels in a cut. This cut is one made during the construction of the new highway up the Cache la Poudre valley over the high mountains into North Park, Colorado. The writer was informed that this tooth was found in a gravel cut less than half a mile from the crest of Cameron Pass. In this event, this record would be from an altitude of nearly or quite 10,000 feet. The writer has noted deposits of coarse rock and gravel, probably mostly of glacial origin, in this vicinity, but has done no work upon them there.

Still another mammoth molar, this time a lower, was shown the writer, while on a deer hunt, by a miner near Breckenridge, Colorado, who stated that it had been found in placer gravels within five miles of that town. Again, it was apparently from the same species, as nearly as could be determined in its damaged state; and this was found at an altitude probably well over 10,000 feet, as nearly as we could judge from known elevations, and without instruments or other means of readily determining the altitude in the time available. It is probable that the scarcity of any but most fragmentary remains, in such deposits, in these high altitudes, is due to the coarse materials generally present, which would tend to grind and crush all bones not most favorably protected; and also, the comparative scarcity of any other type of sediments in these high mountains, which are being exposed by erosion or otherwise, at this time, in deposits which might be expected to produce such remains, rather than to suppose that mammoths were necessarily scarce in the region, when present.

These finds were not seen in place by the writer, so that no detail of the deposits, beyond that given, is possible. The general facts of the occurrence are, however, believed to be reliable. Added to the information previously given, these instances seem to indicate clearly that mammoths of this sort once ranged the high mountain ranges of Colorado; and the specimens seen seem to indicate an early race of the Columbian mammoth. This would seem to point to relatively early Pleistocene times. It will be interesting, when more data has been collected, to learn more of the precise dating of these occurrences. It may throw light on a number of questions of importance. The instances cited are too incomplete to give much desirable data; but they are recorded in the hope that it may cause others, who have the opportunity to visit these interesting regions, to be on the watch for more discoveries, or for new information that will add to our knowledge of these problems.

HAROLD J. COOK
COOK MUSEUM OF NATURAL HISTORY,
AGATE, NEBRASKA

BEACH SANDS OF THE ATLANTIC COAST

RECENT investigations of certain of the Atlantic Beach sands of the United States have disclosed some interesting facts. About 120 samples with a geographical range from the northern end of Long Island to Georgetown, S. C., were studied. Most of these samples were obtained through the cooperation of the U. S. Coast Guard Service; the remainder, except in one or two instances, were collected by the investigator. It is planned to extend this study to the sands farther south if enough samples from the coasts of South Carolina and Georgia can be obtained. One of the graduate students in the department of geology is now carrying on a petrographic study of certain selected samples of the sands already collected, but, inasmuch as this work is very time-consuming and will not be completed for some months, he plans to publish the petrographic work as a separate paper at a later date.

In the course of the present study the sands were subjected to a careful mechanical analysis, to a preliminary microscopic examination, and $CaCO_3$ determinations were made. The localities were studied through various maps and charts, chiefly those of the Coast and Geodetic Survey, and in some cases were visited. While the results of this study will appear elsewhere in full, certain conclusions seem to warrant brief mention at this time.

1. The coast may be divided into several rather distinct sections so that the sands of any one section show close relationships in respect to grain size, $CaCO_3$ content, mineralogical composition, etc. These divisions of the coast are, in the main, limited by natural breaks in the continuity of the beaches, *e.g.,* New York Harbor, Chesapeake Bay, Delaware Bay, etc.

2. The general movement of the sand appears to be southwestward along the coast in accordance with the usual conception, although the direction of drift seems to be in places reversed so that for comparatively short distances the movement is in the opposite direction.

3. There is rather strong evidence that the *effective shore currents* near the mouths of large bays and estuaries move toward such openings even if this involves a local reversal of the general drift toward the southwest. It appears most probable that this effect is caused by the action of tidal currents sweeping in and out of such openings.

4. While in general the sand at any one locality seems to have been transported there from a more northerly region, there is considerable evidence that a portion at least has been supplied locally. In several instances evidence of offshore submarine erosion with deposition on the beaches has been found.

5. In almost all cases each sample shows a very regular distribution of grain size implying that the entire sample has had approximately the same history during the immediate past, although in a few cases the size-distribution curve shows a double peak which would seem to indicate that such a sample might be composed of two different lots of sand which had been intermingled on the beach.

6. North of Caffeys Inlet the $CaCO_3$ content of the sand is almost negligible, never rising above 0.6 per

cent., whereas south of this point the $CaCO_3$ content is always considerable, reaching a maximum of 17 per cent. in North Carolina. Farther south, judging from inadequate samples, even higher figures are reached: a sand from Flagler Beach, Florida, contains 57 per cent. $CaCO_3$.

7. Although on superficial examination the shell fragments seem to be concentrated in the coarser fractions of the sand, in almost all the samples tested the sand averages slightly coarser after the shell material has been leached out by dilute HCl, implying that more of this material exists in a fine than in a coarse state. However, the differences in fineness between the leached and unleached sands are usually so slight that for ordinary purposes no account of the shell material need be taken when the average fineness of a sand is computed.

8. There seems to be a slight tendency for the coarser sands to contain the most $CaCO_3$, although this tendency is so slight that its reality might perhaps be questioned.

A more detailed paper is in the course of preparation, and will appear elsewhere in the near future.

GERALD R. MACCARTHY
UNIVERSITY OF NORTH CAROLINA

THE SPECIFIC EFFECT OF VITAMIN B ON LACTATION, GROWTH AND WATER METABOLISM[1]

IN previous communications it has been demonstrated that when the maternal diet is inadequate in vitamin B there develops, just as in the case of non-lactating rats, a reduction in food intake during lactation,[2] and, in the absence of specific information, the failure of nursing young on such a dietary régime was attributed entirely to the reduction of the plane of nutrition. We now have conclusive evidence that vitamin B, in addition to stimulating the appetite, exerts its specific beneficial influence on the animal organism, as evidenced by the lactation efficiency index, unrelated to food intake. Such results have become apparent by the introduction of the paired feeding type of experimentation, *i.e.*, lactating females are restricted to the same amount of the daily intake of food and water as the litter mates receiving the vitamin B deficient ration. Keeping the plane of nutrition constant, the effect of vitamin B *per se* on the reduction of infant mortality and growth of nursing young becomes very pronounced. In addition, we are at present finding that vitamin B exerts its *specific* influence on growth, also that there is a definite relationship between water and food intake in this avitaminosis. An excess of the proportionate amount of water to the reduced food intake, after this deficiency disease has progressed to the more accentuated stages, is detrimental to the organism. These observations will soon appear *in extenso* elsewhere.

BARNETT SURE
M. C. KIK
M. E. SMITH
D. J. WALKER
DEPARTMENT OF AGRICULTURAL CHEMISTRY,
UNIVERSITY OF ARKANSAS,
FAYETTEVILLE, ARKANSAS

1 Research Paper No. 197, Journal Series, University of Arkansas.

2 B. Sure, *J. Biol. Chem.*, 1928, 76, 685; *J. of Nutr.*, 1928, 1, 139.

3 A. Gulick, *Amer. J. of Physiol.*, 1922, 59, 483; *ibid.*, 1924, 68, 131; J. C. Drummond, and G. F. Marrian, *Biochem. J.*, 1926, 20, 1229; H. H. Mitchell, and J. R. Beadles, *J. of Nutr.*, 1930, 2, 225.

THE ESKIMO WORD "IGLU"

THE article by the Reverend George W. Lay in SCIENCE of December 5, last, says that "if one is going to use a phrase or word from a foreign language, it is quite necessary to know the meaning in that language." There is a special reason for applying this principle to the Eskimo word *iglu* (*igloo, igdlu*) which crops up with increasing frequency all the way from kindergarten songs through travel tales, school geographies and movie titles to anthropological manuals and text-books on architecture.

Many of the text-book writers and probably all the movie directors think that "*iglu*" is the Eskimo word for snowhouse. But few scholars have known better the language they wrote about than Samuel Kleinschmidt knew the Eskimo of western Greenland. Defining *iglu*, he says:[1] "A house. It appears this word . . . was formed from *ikiva* and therefore the fundamental meaning appears to be something within which to lay or shelter oneself; the house is therefore spoken of as a *shelter from the weather.*" (Italics ours.)

This definition was a result of a lifetime spent by Kleinschmidt in Greenland; I have spent ten winters among the Eskimos of Alaska and northern Canada applying myself steadily to the language, and one result is my definition of *iglu* as *a more or less permanent shelter for man or beast.*

Naturally, this very general word is used in any district most often for that type of shelter which is there most common—if *iglu* is in use in that dialect.

Noticing that *iglu* is, in the Smith Sound district of Greenland, most commonly used for houses of earth over a framework of wood, bones or stone, Ekblaw[2] discusses *the difference between iglus and snowhouses.* Other writers have done the like for other districts

1 "Den Grönlandske Ordbog," Copenhagen, 1871.

2 "The Material Response of the Polar Eskimo to Their Far Arctic Environment," Annals of the Association of American Geographers, Vol. XVII, December, 1927.

where some other form of house is commoner than the snowhouse. These are many, for of an estimated current population of 40,000 in all countries, there are less than 10,000 Eskimos who have seen snowhouses and more than 30,000 who have not. There was probably a similar ratio fifty or a hundred and fifty years ago.

When we write English about Eskimo houses, why not call them houses? Then we can use adjectives or qualifying phrases to indicate which of the many types of Eskimo house it is that we are dealing with—sodhouse, snowhouse, earth-covered log cabin, pile dwelling, or what not.

VILHJALMUR STEFANSSON

THE HARVARD CLUB,
NEW YORK CITY

TRUTH VERSUS ADVERTISING

THERE appeared large advertisements quite recently in about two hundred and fifty of the largest newspapers throughout the country, in magazines and other media of advertising, proclaiming that I say that a certain tooth paste is made from the most effective agents and is to be preferred, that I agree with a certain "eminent international scientist" who finds this tooth paste is greatest of the thirty-three dentifrices he tested, that I agree with another "distinguished scientist" to the effect that as a cleansing dentifrice this tooth paste has no equal. Some of these advertisements elaborate at length on the fact that the tooth paste "has the greatest action because of its low surface tension." The same ads carry the statements that I agree with these observations.

In the interest of justice to plain truth and in fairness to myself I hope you will let me state in your columns that I have never made such claims for any dentifrice, in fact my own work doesn't show any great difference in cleansing action between the different soap—abrasive (chalk, etc.) dentifrices. As to the matter of surface tension, I have never seen the work referred to and know nothing of it. It seems plausible that the large amount of soap present would lower the surface tension of the tooth paste-saliva mixture, but if that is the main thing desired why not just use soap?

I have given permission to publish a statement from an earlier publication (1923) based on my work. This statement reads "First, that the resting saliva of the ordinary person, while very slightly acid, is practically neutral; and if its slight acidity has any possible injurious effect, it is insignificant in comparison with that due to decaying food particles. Second, it follows that a dentifrice the chief object of which is to clean the teeth and which is compounded primarily with a view to incorporating in it the most effective cleansing agents, is to be preferred to one which relies primarily upon ingredients put in to effect other objects."

H. H. BUNZELL, PH.D.

NEW YORK, N. Y.

SCIENTIFIC BOOKS

Peru from the Air. By LIEUTENANT GEORGE R. JOHNSON, with Text and Notes by Raye R. Platt. New York: The American Geographical Society, 1930, 177 pp., 142 aerial photographs, 11 maps and sketches. Price $5.00.

To attempt a review of this extremely interesting book, without having visited Peru, is somewhat presumptuous, but after reading the book the reviewer is more than ever convinced that aerial photographs offer the geographer the best available medium for illustrating the physiography of a country, and he now feels that he has a better conception of the topography of Peru than he could possibly acquire by a tour of any reasonable length. Most of the readers of SCIENCE living in the United States have traversed the Allegheny Mountains either by train or by motor, but even if they have ridden over every railroad and motored over every highway in this region they can not begin to have as comprehensive an impression of its topography as they could get by a few flights in an airplane. Perhaps only a small proportion of the students of geography have had the funds or the inclination for travel by air over the regions they wished to study, but travel rates by air are now about as cheap as by rail and modern airplanes are if anything safer vehicles for travel than automobiles. But even if the geographer can not or is not willing to fly, the camera can record all the features he could have seen and, with proper titles and descriptive notes, the photographs offer him a substitute which is often better than the reality.

This is the second book of this kind published by the American Geographical Society. "The Face of the Earth as seen from the Air," by Willis T. Lee, is already a classic and is in the libraries of most American physiographers. "Peru from the Air" is even better because it gives a comprehensive cross-section of the topography of the region under discussion rather than scattered physiographic types.

The arrangement of the book is unusual. In the first place, the author is really Mr. Platt, and the title might well have been "Peru from the Air, by

Raye R. Platt, illustrated by aerial photographs taken by Lieutenant George R. Johnson." It is true that Johnson's photographs made the book possible, but without Platt's descriptive text and explanatory notes the publication would have failed entirely as a monograph on the geography of Peru. The fact that Platt is a member of the staff of the American Geographical Society is probably the cause of this submerging of authorship credit. However, the photographs are so excellent in quality and tone and the air view-points have been selected with such good judgment that Johnson can not be given too much credit for his efforts.

The forty pages of text are called an "Introduction" but really form a brief but comprehensive monograph on the Peruvian landscape. The complete—even voluminous—titles of the photographs which follow supplement the text in an admirable way and carry the reader first along the coast and through the coastal valleys and ranges, next through the high pampas, then over the old volcanoes of the western Andes, and finally over the eastern valleys and lowlands.

The half-tone work is excellent, and apparently little has been lost in reproduction of the photographs, a pleasing and somewhat unusual result of efforts of this kind.

Almost any of the photographs taken at random offer fascinating subjects for study; for example, the five photographs of the Colca River Canyon and Valley reproduced in Figs. 23 to 28 show the character of the high surrounding mountains, steep canyons and deeply eroded valleys, with a minuteness of detail that at each glance reveals new and interesting features which compel the reader to study first one and then another repeatedly. The photograph of the Paramonga sugar plantation reproduced in Fig. 69 gives a more comprehensive view of this large and modern agricultural development than would be possible by any other means. The sand dunes back of Ancon, shown in Fig. 77, as well as other photographs of sand hills and dunes, present material for study of prevailing winds and show how the sand has encroached on the town and limited the usefulness of an excellent seaport.

The large number of photographs of headlands, bays and seaports give the reader an excellent conception of the coast line of Peru—probably a better one than a sea traveler can get even by cruising close inshore. These views are made all the more interesting by Platt's descriptive titles, based on his intimate knowledge of the geography and economic conditions of the country.

The mountain photographs are remarkable. The views of El Misti in Figs. 21 and 122 could possibly be duplicated from ground stations, but those of the crater of this old volcano, shown in Figs. 123, 124 and 125, could not be secured except from the air. The views of the lava fields at the base of this mountain, shown in Figs. 126 and 127, exhibit a wealth of detail that would delight a topographer engaged in mapping the region, for all he would need to secure in the field would be of a few elevations and positions and he could draw the details later in his office better than he could in the field. In this case, the two photographs overlap, but the page arrangement is unfortunate and should be reversed to show the proper sequence.

The mosaic of the Chillon Valley shown in Fig. 3 is an excellent example of the art of mosaic making. The assemblage of photographs is well matched and well toned, so that it is difficult to find the cut lines. Moreover the illustration has apparently lost none of the detail of the original, which is somewhat unusual in copying mosaics. The other mosaic of the pueblo of Pisco, shown in Fig. 110, is not so well reproduced, and suggests a considerable amount of retouching by the artist, and some enlargement in copying. However, the details are clear and the pattern of the streets and buildings in the old town is exceedingly interesting.

Another and very much older example of "town planning" is illustrated in Figs. 11 and 12, which show the pre-Incaic "palaces" of Chan-Chan. These two photographs overlap, and again the arrangement is faulty and the two photographs should have been interchanged, so that the reader could see them in panoramic form.

The reviewer's only warrant for discussing the book is to encourage the effort, to ask for more, and to recommend its reading by all who are interested in geographic study.

C. H. Birdseye

Washington, D. C.

A NEW BOOK ON BEETLES

In 1883 Drs. John L. LeConte and George H. Horn, the two most eminent coleopterists this country ever had or probably ever will have, issued, as No. 507 of the Smithsonian Miscellaneous Collections, their "Classification of the Coleoptera of North America." Based upon their practical knowledge of the anatomy of typical members of the order Coleoptera and the correct function of the various organs of the body of a beetle, gained through long years of intensive study, and their familiarity with the literature then extant of the most noted of European coleopterists, LeConte and Horn brought together in one volume a veritable storehouse of knowledge regarding the structure, relationship and classification of the beetles at that time known to science of the entire

North American Continent. For years it served as the stimulus and basis for all work on the taxonomy of the families and genera of the Coleoptera of this country.

Since this noted work appeared two generations have come and mostly gone. Many coleopterists of note, as E. A. Schwarz, Frederic Blanchard, Thos. L. Casey, H. C. Fall, F. E. Blaisdell, E. C. Van Dyke, Chas. Schaeffer, Chas. W. Leng, W. D. Pierce and a score of others, have prepared monographs of many families, subfamilies or tribes in which they have founded hundreds of genera and described thousands of new species. However, until now, no one has attempted to bring together in one volume, covering the entire country, a work showing the relationship of these new subfamilies and genera and giving keys which would enable the student to determine and make the proper generic placement of his specimens taken afield.

Such a work, long needed, has just appeared in the form of a clothbound quarto volume of 360 pages entitled "A Manual of the Genera of Beetles of America North of Mexico." It was prepared by Dr. J. Chester Bradley, professor of entomology and curator of invertebrate zoology in Cornell University, and is published by Daw, Illston and Company, of Ithaca, New York. In his preface Dr. Bradley states that he "has been compelled to undertake the work for the use of his students in their laboratory work, as they stood in need of a manual that will correspond with present ideas on the classification of the order."

This manual is, as the subtitle informs us, a compilation of "Keys for the Determination of the Families, Subfamilies, Tribes and Genera of Coleoptera with a systematic list of the Genera and Higher Groups." As Dr. Bradley states, his work as compiler "has been to select, rearrange, abbreviate, combine and translate keys from all the most recent sources scattered throughout the world's literature on insects."

His work has apparently been well done, and the original source of each key has, for the most part, been given. The manual is essentially a book of keys, but there are brief characterizations of each of the 111 families of Coleoptera recognized as belonging to the fauna of North America; with a note referring to the principal habitats of its members. In most cases two or more clear-cut characters are used in separating closely allied genera. In but few instances are there indefinite characters of little or no value but which are often used in keys. Examples of these are: "body small in size" and "body very much larger in size." In such cases the approximate length, as (1.–2.3 mm) or (6–9 mm), should have been added in parentheses. No authority or date of founding is given for any of the genera nor are any synonyms (except those of a few of the families and subfamilies) mentioned. For these Dr. Bradley's Manual will have to be used in connection with Leng's "Catalogue of the Coleoptera of America North of Mexico" and the supplement thereto, whose sequence and nomenclature it closely follows. With these two books the average student, with a little practice, should be able to readily identify and arrange as far as the genera his specimens of beetles. For the naming of the species, especially the majority of those from west of the Mississippi River, he will still have to search through many monographs and periodicals until some one or more coleopterists can devote the time and patience necessary to bring forth a "Manual of the *Species* of Coleoptera of America North of Mexico." Let us hope that this will soon be done and that it will be as complete and comprehensive as Dr. Bradley's "Manual of Genera."

W. S. BLATCHLEY

DUNEDIN, FLORIDA

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A COOLING UNIT FOR LOW-TEMPERATURE THERMOSTATS

DIFFICULTY in maintaining temperatures between 0° and that of the room may be overcome by using a SO_2 compression circuit.[1] Such a scheme will control the temperature of an ordinary bath to within ± 0.01° C. for days without requiring any attention. However, in experiments where it is possible to give attention occasionally to the operation of the thermostat, the following cooling unit which will give a constancy of temperature regulation to within ± 0.01° C. can be substituted. Its cost of construction is about $1, as compared with about $250 required for assembling a cooling unit made up with a commercial SO_2 compressor.

The details of construction appear in Fig. 1. The spout of a copper funnel is closed by a rubber stopper or by a piece of copper. A hopper made of heavy linoleum (smooth surface *inside*) or of some other non-conducting material is attached to the top of the funnel. The hopper is filled with pieces of cracked ice about the size of a walnut and is snugly closed by a felt pad. To insure efficient operation water from the melting ice must be quickly removed by a syphon working in conjunction with a constant level

[1] W. J. Crozier, and T. J. B. Stier, 1927, *J. Gen. Physiol.*, X, 503.

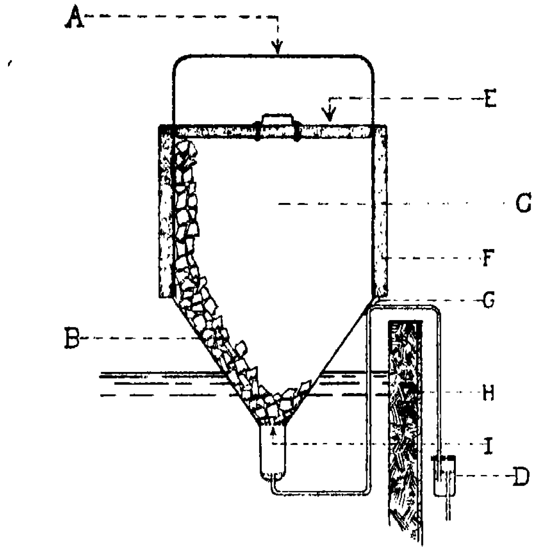


Fig. 1. *A*, cooling unit to be attached by its strap-iron handle to a system of pulleys or a heavy "ring stand"; *B*, copper funnel, 8 inches in diameter; *C*, hopper containing 20 pounds of cracked ice; *D*, constant level device, clamped to ¼-inch copper pipe which is soldered to the funnel at *G*; *E*, heavy linoleum lid; *F*, walls of hopper made of heavy linoleum; *H*, wall of thermostat, insulated by a layer of felt; *I*, removable brass sieve.

device, or by a suction line attached to a water aspirator.

By means of a pulley system and a counterweight the conical portion of the funnel is lowered into the water bath (or air thermostat) to different levels. A position is found, by trial, where the heat removed from the bath is roughly equal to the heat added from the air. Regulation of temperature within the body of the thermostat is obtained by setting the cooling unit so that it undercools the tank, constancy being maintained automatically by a large-capacity mercury thermoregulator actuating a relay-controlled bank of heating lamps (*cf.* Crozier and Stier, 1927, *ibid*).[2]

The following tests of this device were made in a well-insulated thermostat containing 10 gallons of water, adequately stirred by a motor-driven agitator. Fluctuations of temperature of the water were estimated to within 0.001° C. by a Beckmann thermometer.

Ice was not replaced more frequently than once every 1½ hours. The cooling unit could be made to function without attention for 12 hours if the storage space for ice were increased and if the ice were moved into the metal funnel at a uniform rate by a motor-driven agitator.

[2] A simple form of this device, involving regulation by manual control of the depth of immersion of the funnel, was made by the writer during 1929–30, in the Physiological Laboratory, Cambridge, England.

TABLE I

	Room temperature	Extreme variation of temperature within the thermostat	Constancy	Amount of ice used
	°C.	°C.	°C.	lbs.
Cu needle in thermoregulator	16.1 to 19.6	5.946 to 5.914	± 0.016 for 5½ hrs.	10
	17.5 to 18.1	5.919 to 5.881	± 0.019 for 7½ hrs.	25
Nichrome needle in regulator	13.8 to 19.1	16.989 to 16.971	± 0.009 for 4½ hrs.	3
	16.6 to 20.3	4.007 to 3.993	± 0.007 for 4 hrs.	14

If a more sensitive system of thermoregulation were employed in conjunction with this cooling unit, one might obtain a constancy of temperature control even closer than ± 0.007° C.

T. J. B. Stier,
National Research Council Fellow
Laboratory of General Physiology,
Harvard University

A VACUUM TUBE METHOD OF TEMPERATURE CONTROL[1]

It is customary to regulate the temperature in water baths used in biological and physical chemical work by arranging a competition between the cooling effect of water flowing through a copper coil, and the heating effect of the electric current passing through a submerged resistance unit. The flow of water is usually set at an arbitrary rate while the electric current is controlled by a platinum-mercury contact through an electromagnetic relay.

This relay system has been a source of considerable annoyance in the past owing to the pitting of the relay contacts and to the fouling of the mercury surface of the thermoregulator owing to the passage of relatively high currents, usually of the order of 0.1 ampere, which resulted in considerable temperature fluctuation. This was particularly objectionable in certain experiments on nerve metabolism where temperature fluctuations in over-night runs were sufficient to ruin a number of experiments. To eliminate this difficulty we have devised a vacuum tube relay which has proven so surprisingly superior in every respect to the electromagnetic relay that it was considered of sufficiently general interest to warrant brief description.

As stated, the chief objection to electromagnetic

[1] From the Department of Zoology, Washington University, St. Louis, Missouri.

relays is the relatively large current which passes across the contacts. This objection has been eliminated by the use of the new Thyratron regulator tube, type FG-27, made by the General Electric Company. This is a mercury vapor tube capable of controlling a peak current of five amperes by means of a grid in which a current of less than 0.1 milliampere may flow. Thus by inserting the toluol-mercury regulator in the grid circuit of the Thyratron unit the current passing across the mercury surface has been reduced over a thousand fold. The circuit is as shown in Fig. 1.

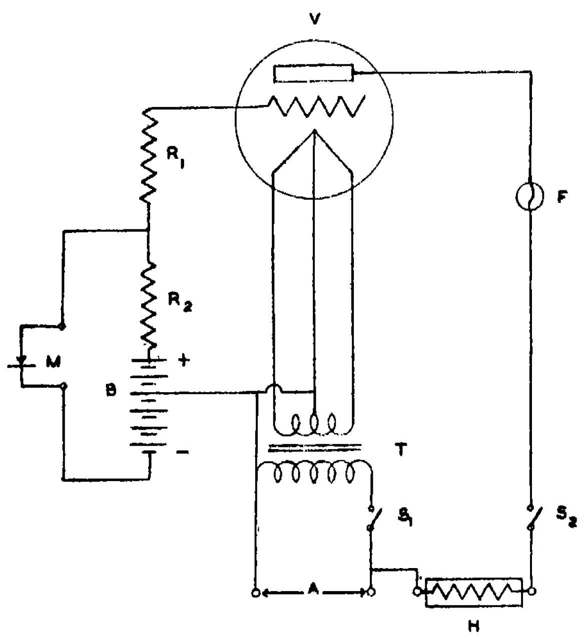


Fig. 1. A, 110-volt *alternating-current* source; B, two standard size 4½-volt "C" batteries; M, contacts of toluol-mercury thermoregulator; F, five-ampere, auto-type fuse; H, submerged heater resistance unit; R_1, one megohm cartridge resistor; R_2, 100,000 ohm cartridge resistor; S_1 and S_2, switches; T, five-volt, 25-watt center-tapped transformer; V, Thyratron tube, type FG-27.

It is recommended that resistance R_1 be at least one megohm to prevent the backing up of the plate current through the toluol thermoregulator. The value of R_2 should lie between 25,000 and 100,000 ohms; its purpose is to prevent the rapid discharge of the battery and the fouling of the mercury surface when the contact M is closed. The fuse F is inserted to project the Thyratron should the heater unit become grounded by water. The Thyratron is unique among thermionic tubes in that its filament is center tapped. The plate return must be made through this center tap to prevent the plate current adding itself to the filament current in one arm of the filament. The optimum position on the battery of the lead from the center tap varies from tube to tube but is usually about as represented. The filament switch S_1 *must* remain closed for at least five minutes before closing the switch S_2 in the plate circuit. Failure to observe this precaution may seriously decrease the useful life of the tube. Working at full load the efficiency of the entire unit is about 75 per cent.

In choosing a heater unit to be used in conjunction with the Thyratron relay one must bear in mind that only half of each cycle is utilized and that a 15-volt drop obtains across the tube. Hence, if 110 volts is being used, the value of the desired heater unit should be multiplied by a factor of about 2.3. Thus, if 200 watts must be dissipated, a unit of $200 \times 2.3 = 460$ watts rated capacity must be chosen.

Incidentally, we have found it very convenient to utilize the rectifying properties of the Thyratron to charge laboratory storage batteries. For this purpose it is only necessary to insert the batteries in the plate circuit in such a way that the battery cathode is connected to the plate. In this way as many as nine cells may be charged without interrupting experimentation, since the tube functions simultaneously as a relay and as a rectifier.

Our experience with the above described unit has been most gratifying. Using an ordinary large uninsulated metal water bath, temperature control to at least 0.005° C. has been maintained in experiments lasting over a period of days. For physical chemical experiments in which well insulated water baths are used, control to within 0.001° C. is easily realizable. Servicing of the unit consists solely in replacing the "C" batteries twice each year; the life of the Thyratron may be estimated to be at least a thousand hours of actual operation.

Francis O. Schmitt
Otto H. A. Schmitt

Washington University,
St. Louis, Missouri

SOCIETIES AND ACADEMIES

THE SPOKANE MEETING OF THE NORTHWEST SCIENTIFIC ASSOCIATION

The seventh annual meeting of the Northwest Scientific Association was held at Spokane, Washington, in the Davenport Hotel on Monday and Tuesday, December 29 and 30, 1930. The meetings were presided over by the president, Francis A. Thomson, president of the State School of Mines, Butte, Montana.

At the opening general session, on December 29, an address was delivered by T. C. Spaulding, dean

of the school of forestry, State University, Missoula, Montana, on the subject, "Some Aspects of Present Day Research in the Inland Empire." Following the address members engaged in a general discussion.

In the afternoon the general session was devoted to a program presented by the medical section.

The annual dinner of the association was held the same evening in the Hall of the Doges, Davenport Hotel. The annual address of the retiring president was given by Dr. John A. Kostalek, University of Idaho, Moscow, Idaho, on the subject "The Utilization and Conservation of our Carbon Resources."

The general sessions of the second day included a business meeting and a luncheon of the association. At the former meeting, in addition to other matters of business, the association instructed the secretary to arrange for affiliation with the American Association for the Advancement of Science as an academy, retaining the present name. At the latter meeting an address was given on the subject "The Advent of the Railroads into the Pacific Northwest," by Dr. E. A. Bryan, State College of Washington, Pullman, Washington.

At this meeting, also, in addition to the customary resolutions, a resolution was passed commemorating the services of Dr. M. F. Angell, deceased, a valuable member of the organization and its first president.

In addition to the general sessions, section meetings were held by the following groups on both days of the meeting: Botany-zoology, chemistry-physics, education, psychology, engineering, forestry, geology-geography and social science.

Northwest Science, the official publication of the association, is now entering upon its fourth year of existence and has conclusively demonstrated its usefulness as an avenue for publication in this region.

The following officers were elected:

President, President E. O. Holland, Washington State College, Pullman, Washington; *Vice-president*, Carl Von Ende, University of Idaho, Moscow, Idaho; *Secretary-treasurer*, J. W. Hungate, State Normal School, Cheney, Washington; *Councilor*, President C. H. Clapp, State University, Missoula, Montana; *Trustee*, J. W. Hungate, State Normal School, Cheney, Washington.

Section Officers

Botany-Zoology: Chairman, Charles W. Waters, State University, Missoula, Montana; *Secretary*, Charles E. Cone, Ephrata High School, Ephrata, Washington.

Chemistry-Physics: Chairman, B. C. Neustel, Whitworth College, Spokane, Washington; *Secretary*, Rudolf Meyer, Lewis and Clark High School, Spokane, Washington.

Education: Chairman, R. F. Hawk, State Normal School, Cheney, Washington; *Secretary*, I. N. Madsen, State Normal School, Lewiston, Idaho.

Engineering: Chairman, Richard McKay, Washington Water Power Company, Spokane, Washington; *Secretary*, Ellery Fosdick, Washington Water Power Company, Spokane, Washington.

Forestry: Chairman, J. H. Ramskill, State University, Missoula, Montana; *Secretary*, K. D. Flock, U. S. Forest Service, Missoula, Montana.

Geology-Geography: Chairman, Otis W. Freeman, State Normal School, Cheney, Washington; *Secretary*, F. B. Laney, State University, Moscow, Idaho.

Medicine-Surgery: Chairman, C. M. Anderson, Spokane, Washington; *Secretary*, Clarence Lyon, Spokane, Washington.

Social Science: Chairman, T. S. Kerr, State University, Moscow, Idaho; *Secretary*, Louis E. Livingstone, Lewis and Clark High School, Spokane, Washington.

J. W. HUNGATE

SECRETARY-TREASURER,
CHENEY, WASHINGTON

SPECIAL ARTICLES

ON THE MONOMETHYL-GLUCOSE OF PACSU

FOR an investigation now in progress in this laboratory, 4-methyl-glucose was required, and as Pacsu[1] had prepared a substance to which he ascribed this structure, we undertook its preparation by his procedure. However, in a recent paper, Brigl and Schinle[2] describe 2-methyl-glucose with physical properties practically identical with those given by Pacsu for his methyl-glucose. Moreover, the 2-methyl-1, 1-diethylmercapto-d-glucose of Brigl and Schinle is apparently identical with the methyl-1, 1-diethylmercapto-d-glucose which resulted when we extended Pacsu's procedure to diethylmercaptoglucose. These considerations led us to subject the methyl-glucose of Pacsu to more rigorous test.

On treatment with phenylhydrazine in methyl alcohol solution, the methyl-glucose gave a methyl-hexose phenylhydrazone which had the same properties as the corresponding derivative of the 2-methyl-glucose of Brigl and Schinle. Moreover, like their 2-methyl-glucose, on heating with excess phenylhydrazine in dilute acetic acid solution, it lost the methyl group and gave glucosazone, and not a methyl-hexosazone, as reported by Pacsu. Additional supporting evidence was obtained from the study of the glucoside formation and from the study of the products of oxidation.

Thus, the identity of the methyl-glucose of Pacsu

[1] E. Pacsu, *Ber. chem. Ges.*, 58, 1455 (1925).

[2] P. Brigl and R. Schinle, *Ber. chem. Ges.*, 63, 2884 (1930).

with the 2-methyl-d-glucose of Brigl and Schinle has been definitely established.

P. A. Levene
G. M. Meyer
A. L. Raymond

The Rockefeller Institute
for Medical Research,
New York

THE EFFECT OF PHYSICAL AND CHEMICAL AGENTS ON THE OOCYSTS OF EIMERIA TENELLA

Coccidiosis in the domestic hen, *Gallus gallus*, represents a typical parasitological picture. The reservoir is the adult bird acting as a chronic carrier and disseminating a few oocysts. These oocysts under favorable conditions sporulate, and become infective to new hosts. Once the infection is established in younger birds, acute coccidiosis usually results and can only be checked in two basic ways: first, by removal of the infected birds, either by death, isolation or therapeutic measures; and secondly, by preventing the access of uninfected birds to the infective oocysts by sanitation or the creation of conditions unfavorable to the extra-corporal stages of the parasite.

Isolation or death of the infected birds is a costly and generally impractical method of control and, to date, no effective therapeutic agent has been found.

Unless sanitation is rigidly and thoroughly employed, an undercurrent of acute coccidiosis results, which may at any time break out into a devastating epidemic. In large poultry establishments, strict sanitation represents a large economic factor which depletes the net profits to the concern.

The exact conditions necessary for the development of the freshly passed, unsegmented oocyst into the mature, infective stage are but vaguely known, and practically nothing has been reported regarding the lethal limits of the oocysts. With this in mind, the writer has been directing his work toward a possible weak link in the parasitological cycle which will be of economic significance in the control of coccidiosis in poultry.

The results reported in this paper represent a progress report of the work now being undertaken in this laboratory. All work has been done on *Eimeria tenella*, the pathogenic species of coccidium in hens, isolated and described by Tyzzer[1] in 1929.

The prepatent period of coccidiosis produced by *Eimeria tenella* is approximately 165 hours regardless of the number of infective oocysts ingested by the host. There seems to be no correlation between the size of the infecting dose and the height and duration of the patent period. This is not surprising since, as Tyzzer has shown, many factors may enter into the situation before oocysts are produced in the host.

There appears little, if any, difference in the susceptibility of the segmented and unsegmented oocysts to heat as shown in the following table:

TABLE I

Temperature	Segmented oocysts, infections produced				Unsegmented oocysts, mortality percentages
51° C.	+	+	+	+	23.5
53° C.	–	+	+	o	100.0
54° C.	+	–	–	–	100.0
55° C.	–	–	–	–	100.0
Controls uninfected	–	–	–	–	
Controls unheated	+	+	+	+	0.0

Time of exposure, 10 minutes

The criterion used for viability of segmented oocysts was their ability to produce infections when fed in large numbers to chicks known to have been coccidia-free since hatching. The criterion used for viability of unsegmented oocysts in all experiments was their ability to segment when placed in a 2½ per cent. solution of potassium dichromate at 20° C. for 72 hours. All figures, in this and succeeding experiments, are exclusive of natural death and hence represent the mortality due to experimental conditions only.

The time required to kill washed, unsegmented oocysts is inversely proportional to the degree of heat used. Tabulated, the time required for 100 per cent. mortality of unsegmented oocysts is:

TABLE II

Temperature	Time required
45° C.	24 hours
50° C.	1½ hours
55° C.	3 minutes
60° C.	15 seconds
70° C.	15 seconds
80° C.	5 seconds
90° C.	5 seconds

Unsegmented oocysts do not show high resistance to ultra-violet rays. Washed oocysts, exposed to rays produced by a mercury vapor lamp, succumbed as shown in Table III.

The unit of ultra-violet rays used was the zinc sulfide unit of Clark.[2]

Certain reagents were also used in attempts to kill washed, unsegmented oocysts. Briefly, the technique

[1] E. E. Tyzzer, "Coccidiosis in Gallinaceous Birds," *Am. Journ. Hygiene*, X, No. 2, 1, 1929.

[2] J. H. Clark, "The Zinc Sulfide Method of Measuring Ultra-violet Radiation and the Results of a Year's Observations on Baltimore Sunshine," *Am. Journ. Hygiene*, IX, No. 3, p. 646, 1929.

TABLE III

Material	Units received	Mortality percentages
Control 1 { Covered with }	0	0
Control 2 { glass slide }	0	0
Slide 1	1/4	8.22
Slide 2	1/4	*
Slide 3	1/2	53.43
Slide 4	1/2	54.75
Slide 5	3/4	98.83
Slide 6	3/4	100.0
Slide 7	1	100.0
Slide 8	1	100.0

* Slide 2 was accidentally destroyed.

employed was to suspend the oocysts in the reagent for the desired time, wash thoroughly, resuspend in a 2½ per cent. solution of potassium dichromate and incubate at 20° C. At the end of 72 hours of incubation, the oocysts were examined and counted. Those failing to develop were considered dead. The results obtained are presented in Table IV:

TABLE IV

Reagent	Strength	Mortality percentages
$HgCl_2$	1 per cent.	100.0
$HgCl_2$	0.1 " "	18.4
Iodine suspensoid		
Merck	5 " "	100.0
NaOH	0.5N	0.5
NaOH	2N	1.1
HCl	0.5N	1.3
HCl	2N	4.5
Chlorazene	4 per cent.	0.0
Formol	2 " "	31.4
Formol	5 " "	40.0
Cresol	2 " "	100.0
Cresol	5 " "	100.0
Phenol	2 " "	99.4
Phenol	5 " "	100.0
Controls	2.5 " "	0.0
Potassium dichromate		

Time of exposure, 48 hours.

The comparative killing power of efficacious reagents are listed in Table V.

It is a pleasure for me to acknowledge the advice and material assistance given me by Dr. Robert Hegner of this department, Mr. Neal A. Truslow, Chestertown, Maryland, and Dr. E. E. Tyzzer, of Harvard University, who furnished me with a culture of *Eimeria tenella*. This work was aided by a grant

TABLE V

Reagent	Strength	Time required for 100 per cent. mortality
Iodine suspensoid		
Merck	5 per cent.	1 hour or less
Cresol	2 " "	4 to 8 hours
Cresol	5 " "	4 to 8 hours
Phenol	2 " "	48 hours

from the Committee on Scientific Research of the American Medical Association.

FREDERIC FISH
SCHOOL OF HYGIENE AND PUBLIC HEALTH,
THE JOHNS HOPKINS UNIVERSITY

GONADECTOMY IN THE GOLDFISH CARASSIUS AURATUS

GONADECTOMY upon fish has not been practiced to any great extent until within the last few years, when the first truly successful operations have been performed. Other work has largely been done to determine the relation between the development of certain secondary sex characteristics, especially nuptial coloration, and the gonads. That relationship has been quite definitely shown to exist. Removal of gonads in the goldfish was undertaken for a different reason, namely, to determine the effect, if any, upon the color change of the young common goldfish from its youthful brown to the orange of the adult. Although there is no difference in the color expression and behavior of the sexes of the goldfish, it was hoped that an upset of a hormonic balance might prove to be of value in a better understanding of the phenomenon, perhaps by changing the rate of time of depigmentation, or even in the total inhibition of the degenerating influence. This work was done as a part of a program of the study of pigment development and pattern formation now in progress at Wesleyan University.[1]

During the autumn of 1928 and 1929 some thirty-nine gonadectomies and twelve operative controls were performed upon young goldfish about five months old. Such fish, hatched in May, were over four centimeters long in October and early November, and no fish under four centimeters was used. Of the complete gonadectomies, twenty-one were upon males and eighteen upon females.

The gonads are paired organs, relatively large and decidedly soft in the goldfish, so that complete removal demands large incisions and careful manipulation. Unfortunately, they do not permit of tearing,

[1] H. B. Goodrich and I. B. Hansen, "The Post-embryonic Development of Mendelian Characters in the Goldfish *Carassius auratus*," in press.

but instead must be carefully severed from their connectives and removed with considerable delicacy.

The method of procedure was somewhat as follows. The fish was placed in a finger-bowl and sufficient saturated aqueous solution of chloretone added to anesthetize the individual in five to ten minutes. When the fish became unconscious it was placed in a paraffin dissecting plate previously hollowed to fit in general the shape of the fish. Two strips of absorbent cotton, moistened well with the solution from the anesthetizing bowl, placed over the head and the caudal peduncle served well to hold the fish in place. The presence of an abundance of the solution permitted the fish to remain in position without attention until the operation was complete upon that side.

It was found that a single median incision was inadequate to remove successfully both gonads. Consequently a lateral incision was adopted and performed upon both sides of the fish. The advantages of the double incision were more absolute certainty of removing all of both gonads, less injury and disturbance to the visceral organs, greater ease in operation and an intact ventral abdominal wall to remain as a firm support to the viscera. The objections are likewise several, the most serious of which is the double incision giving the fish a wound in aggregate twice as large as the median abdominal cut. It further has the disadvantages that practically all the abdominal ribs are cut on both sides and that a relatively large number of scales are removed. Operating time is increased likewise, averaging some twenty minutes.

With the fish securely fastened with the cotton strips, a line of scales was removed from the region just above the anus and extending upward and forward in a curve corresponding to the position of the gonad in the abdominal cavity. The primary break was made by piercing the abdominal wall with a needle and the incision was completed by fine scissors. With the wound open, further work was done with suitable instruments under a binocular dissecting microscope. After the gonad was removed, the wound was closed with one or two stitches of silk thread according to the size of the incision. The process was then repeated upon the other side of the fish. No aseptic methods were used as the probability of infection is slight. Ordinary care was used to keep the wound clean and free from scales.

The fish were kept isolated in finger-bowls and healing took place in about three weeks, by which time the stitches either had pushed out or were removed. Fungus infections were the chief cause of concern, and it was found that the quickest and surest remedy was surgical removal.

As a control, a group of twelve fish were treated similarly, but had no gonadal tissue touched.

Of the thirty-nine complete gonadectomies, thirteen died within a week or so of the operation. The remaining twenty-six healed perfectly, some being still alive and in good condition. The others were killed some six months later to note whether there had been any regeneration of gonadal tissue. Of the controls, only one died.

The results of the experiments were negative as far as the effect upon the pigment change was concerned. All the surviving fish subsequently passed through the color transformation in spite of the gonadectomy operation. The only noticeable effect was the lengthening of time before demelanization took place. This was due to operative shock, for the controls showed the same delay although to slightly lesser degree. Of those fish examined for regeneration tissue, it was observed that without exception some gonadal tissue was to be found, which indicates that regeneration to some degree does take place. In no case was the amount of regenerative gonadal tissue large.

The experiments are not entirely conclusive, but they indicate, first, that the gonads probably have no major rôle in the process of demelanization, and secondly, that the goldfish is excellent material for operative procedure.

Gonadectomy in fishes has been practiced by other workers and with some notable results. Kopeč[2] succeeded in castrating the minnow *Phoxinus laevis*, a fish that shows a nuptial coloration during the mating season. This nuptial change consists of a reddening of many parts of the body, especially the abdomen, and is more distinct in the male. He castrated these fish in a satisfactory fashion by a single abdominal incision just to the right of the mid line. Kopeč was not very fortunate in his post operative success, for all his fish had died at the end of three weeks. He reports evidence that gonad removal suppresses and removes almost entirely the nuptial hue, and believes that the development of the nuptial color in *Phoxinus laevis* depends upon the presence of the gonads.

Evidence of sex reversal in fish such as reported by Blacher[3] for *Lebistes reticulatus*, and Essenberg[4] for *Xiphophorus helleri*, in addition to Kopeč's work, led to three other important papers. Van Oordt and

[2] Stefan Kopeč, "Contribution to the Study of the Development of the Nuptial Color of Fishes," *Spraw. Z. Pos. Tow. Nauk. Warszawskiego*, 3, vol. 11–18, English summary, pp. 108–114, 1918.

[3] L. J. Blacher, "The Dependence of Secondary Sex Characteristics upon Testicular Hormones in *Lebistes reticulatus*," *Biol. Bulletin*, 50: 374–381, 1926.

[4] J. M. Essenberg, "Complete Sex-reversal in the Viviparous Teleost *Xiphophorus helleri*," *Biol. Bulletin*, 51: 98–111, 1926.

van der Maas[5] working upon *Xiphophorus helleri* castrated fourteen males by a single lateral incision upon the side of the fish. Of these only one large male survived. In this individual no effect was noted upon the secondary sex characters, and an autopsy indicated regeneration of the testis containing active sperm. They also tried implantation of testis into the abdominal cavity of a female. The ovaries were left intact. Of the eighteen cases only six survived, and upon these no effect was noted nor did autopsy indicate any testis tissue remaining. They were unable to demonstrate any hormonal relation between the gonads and the secondary sex characteristics in Xiphophorus.

Bock[6] castrated the stickleback *Gasterosteus oculeatus* and presents a successful record of post operative life. He removed the compact gonads through a small ventral slit on the abdomen. For anesthesia he used ether and water. The stickleback is a fish that shows secondary sex coloration in the male appearing in breeding season. Bock definitely found that castration prevented the appearance of that nuptial coloration. If one gonad was left intact the fish still developed the full male coloration, but the intensity was not as great as that in a fish containing both gonads. No generation of gonadal tissue was found.

Tozawa[7] shares with Bock the honor of a conclusive piece of work. He used the Japanese Bitterling, *Acheilognathus intermedium*, and performed gonadectomies both unilateral and total upon both sexes. This fish likewise develops a nuptial color during breeding season with a rather distinct reddening on certain parts of the body. He finds that the appearance of the nuptial coloration and the pearl organs is partially inhibited in the incompletely gonadectomied individuals, and more completely inhibited in the totally gonadectomied group. He agrees with Bock that the nuptial coloration is definitely influenced by a substance or substances produced by the sex glands.

Such work indicates to some degree the adaptivity of fish to operative procedure and the present status of experimental results of gonad removal and transplantation upon fish.

I. B. HANSEN

WESLEYAN UNIVERSITY

[5] G. J. van Oordt and C. J. J. van der Maas, "Castration and Implantation of Gonads in *Xiphophorus helleri* Heckel (Teleost)," Koninklije Akad. van Wetenschappen te Amsterdam. *Pro. of the Sect. of Sciences*, 29: 1172–1175, 1926.

[6] Friedrich Bock, "Kastration und sekundäre Geschlechtsmerkmale bei Teleostiern," *Zeit. für Wissen. Zool.*, 130: 455–468, 1928.

[7] Tomisyu Tozawa, "Experiments on the Development of the Nuptial Coloration and Pearl Organs of the Japanese Bitterling," *Folia Anatomica Japonica*, 7: 407–417, 1929.

THE RELATION BETWEEN THE ESTRUS-PRODUCING HORMONE AND A CORPUS LUTEUM EXTRACT ON THE GROWTH OF THE MAMMARY GLAND

IN connection with a study of the physiological cause of the growth of the mammary gland and the initiation of milk secretion, it has been demonstrated at this station that during pregnancy cattle excrete in the urine increasing amounts of the estrus-producing hormone.[1]

A study was therefore made of the effect of this hormone on the growth of the mammary gland in the rabbit.[2] In the normal rabbit after continued estrus the mammary glands show extreme extension of the duct systems resembling the naked branches of a tree. If pregnancy or even pseudo-pregnancy now ensues, the ducts develop lobules containing large numbers of alveoli, resembling the budding of leaves from the smaller branches. These two types of growth can be distinguished macroscopically in the fixed gland.

It was found that the daily injection of 20 rat units of the estrus-producing hormone recovered from pregnant cow's urine for 30 days in male castrate rabbits and in female rabbits castrated previous to puberty caused growth of the duct system of the glands equal to that produced during continued estrus in the normal female. A slight milk secretion resulted in these cases. The injection of greatly increased amounts of the hormone did not carry the development beyond this stage.

The purpose of the present communication is to report our recent success in developing the type of mammary growth characteristic of pregnancy and pseudo-pregnancy.

In continuing our effort to stimulate experimentally the growth of the mammary gland equal to that observed during pregnancy, it seemed logical next to determine the action of the hormones of the corpus luteum. In our experiments the method of extraction of the crude extract of the corpora lutea of the sow described by Allen[3] was followed. In an attempt to simulate the normal hormonal stimulation at the time of ovulation, an ovariectomized rabbit

[1] C. W. Turner, A. H. Frank, C. H. Lomas and C. W. Nibler, "A Study of the Estrus Producing Hormone in the Urine of Cattle during Pregnancy," *Mo. Agr. Exp. Sta. Res. Bul.* 150, 1930.

[2] C. W. Turner and A. H. Frank, "The Effect of the Estrus Producing Hormone on the Growth of the Mammary Gland," *Mo. Agr. Exp. Sta. Res. Bul.* 145, 1930.

[3] W. M. Allen, "Physiology of the Corpus Luteum. V. The Preparation and Some Chemical Properties of Progestin, a Hormone of the Corpus Luteum which Produces Progestational Proliferation," *Amer. Jour. of Phys.*, 92: 174, 1930.

whose mammary glands showed only the estrus type of development was injected daily with 20 r. u. of the estrus-producing hormone during a period of three days. Following this 1 cc of the crude corpus luteum extract was injected daily for 11 days. No change could be noted in type or extent of growth in glands before and after injection.

Similarly a castrate male rabbit was injected daily with 20 r. u. of the estrus-producing hormone during a period of 30 days. A check gland removed at this time showed the development of the estrus type of growth. The injection of 1 cc daily of the crude corpus luteum extract was begun 10 days later and continued for 30 days. Glands removed at 10-day intervals showed neither additional growth of the ducts nor the pregnant type of development.

A second castrate male rabbit which had received the same previous treatment was injected with 1 cc daily of the crude corpus luteum extract plus 12 r. u. of the estrus-producing hormone. In glands removed at 10-day intervals during a period of 30 days increasing development of both ducts and lobules was observed strikingly similar to that produced during pregnancy.

In a third male castrate rabbit which had received the same previous treatment somewhat greater growth of the ducts and lobules was observed following injection of the same amount of the corpus luteum extract but an increased amount (20 r. u.) of the estrus-producing hormone. Additional experiments are now in progress having as their object the further determination of the effect of increasing amounts of the estrus-producing hormone with constant amounts of the corpus luteum extract.

It will be noted in the previous experiments that the estrus type of development of the ducts of the mammary gland had been produced previous to the initial injections of the corpus luteum extract. In a fourth male castrate rabbit daily injection of 12 r. u. of the estrus-producing hormone and 0.5 cc of the crude corpus luteum extract was made over a period of 30 days. The size and development of the mammary gland characteristic of advanced pregnancy were observed at that time.

These observations lead us to believe that the growth of the mammary glands during pregnancy comes as a result of the combined action of the increasing amounts of the estrus-producing hormone and one or more hormones from the corpus luteum. It should be noted, however, that lactation was not produced in these animals. This may be due to the fact that the injections were continued up to the time of examination of the glands. The initiation of milk secretion may be stimulated by any one of several factors. It is possible that it follows the complete withdrawal of the growth stimulus or it may result from changes in the effective concentration of the two hormones. It is also possible that an as yet unidentified hormone is required. This phase of the problem is at present being studied.

In our study of the effect of the estrus-producing hormone on the growth of the mammary gland it was suggested that the growth observed during pseudo-pregnancy may be due to either one or both of these hormones (estrus-producing and corpus luteum) acting on the uterus, which may in turn produce a hormone or hormones which may be the active agent.

Two separate lines of evidence seem to indicate that the action of these hormones is directly upon the mammary gland rather than through the mediation of the uterus. The production of the growth of the gland in male castrates eliminates the possibility of the uterus acting as a gland of internal secretion. On the other hand, the development of the mammary gland characteristic of pseudo-pregnancy was observed in a hysterectomized rabbit after coitus.

Having obtained the type of growth characteristic of pregnancy by the combined action of the estrus-producing and the corpus luteum extract, it became possible to test for the presence of the active principle in the urine of pregnant cows. In this we have been successful. It has been found possible to produce the growth characteristic of pregnancy with a water and alcohol soluble extract in both castrate male rabbits and rats in combination with the estrus-producing hormone. By using this method it is proposed to trace the changes in the concentration of this active principle (corpus luteum?) in the urine of cows during the course of gestation.

C. W. Turner
A. H. Frank

Missouri Agricultural Experiment Station

BOOKS RECEIVED

Briscoe, Herman T. *Qualitative Chemical Analysis.* Pp. v + 279. 28 figures. Van Nostrand. $2.25.

Griffee, Fred, and others. *Biometrical Analysis of Upland Cotton Grown in Stillwater, Oklahoma.* Pp. 82. Oklahoma Agricultural and Mechanical College Agricultural Experiment Station.

Harger, Edgar B., and others. *Additions to the Flora of Connecticut.* Bulletin No. 48. Pp. 94 + vii. Connecticut State Geological and Natural History Survey.

Keeler, C. de E. *The Laboratory Mouse, its Origin, Heredity and Culture.* Pp. 81. 36 figures. Harvard University Press.

Partridge, William. *Aids to Bacteriology.* Fifth edition. Pp. vii + 311. Wood. $1.75.

Sheldon, J. M. Arms. *Observation Lessons on Animals:* Courses I and II. Pp. 549. 123 figures. E. L. Hildreth.

SCIENCE

VOL. 73 FRIDAY, MARCH 20, 1931 No. 1890

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE NEW CYTOLOGY[1]

By Dr. ALEXIS CARREL

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

CYTOLOGY, if its full significance is given to this term, is the science concerned with cells and tissues, their functions as well as their structure. Such was the conception of Schwann. He considered the living organism as dependent on both metabolic and plastic activities of the cells. But his followers ignored this point of view. They contented themselves with the study of the form, and overlooked that of the function. On account of this fundamental error, the work done for nearly a century by a host of cytologists and histologists has ended in an incomplete science of the cells and the tissues. This science does not show how such cells and tissues are building up organized beings. It is also unable to give an explanation for the most common pathological phenomena, such as the cicatrization of a wound or the growth of a tumor.

[1] From the laboratories of The Rockefeller Institute for Medical Research.

The unsatisfactory nature of our knowledge of the elements of the body must undoubtedly be attributed to the conception on which classical histology is based. Whether dead or living, dissociated on a slide or explanted in a drop of plasma, or sectioned and stained, cells and tissues have been considered as inert forms, unrelated to their environment and deprived of functional activity. They have been abstracted from both space and time. In fact, they have been stripped from their reality. Obviously, the traditional conception has to be given up. In order to replace it by another abstraction containing a larger part of truth, one must return to the close observation of the concrete event which a tissue is.

The first notion gained from this analysis is that cells are in physiological continuity with their environment. Cells and environment form a whole. A cell depends as strictly upon its medium as the nucleus

upon the cytoplasm. Almost a century ago, Schwann described the cells as surrounded by a fluid, the cytoblastema, containing the material required for their nutrition. Later, Claude Bernard demonstrated the *capital importance of internal environment* in the life of the body. Physiology, according to his conception, is based both on the properties of tissues and on the physicochemical conditions of the internal environment, or organic medium. The organic medium is secreted by the tissues and, in its turn, regulates their activity. To a given constitution of the medium corresponds a certain morphological and functional state of the cells. But each cell type responds in its own way to a same environment. We may assume that the state of a tissue rests simultaneously on its hereditary properties and previous history, and on the conditions of its medium. The morphological description of cells of a given type acquires its full significance only when the environment is accurately defined. It is necessary to substitute for the conception of cells and tissues abstracted from their surroundings and isolated in space that of a system cells-medium, and to study at the same time the constituent parts of this system.

Secondly, structure and function are two aspects of the same thing. One can not consider them separately. Each structural detail possesses its functional expression. It is through the physiological aptitudes of their anatomical parts that the life of the higher animals is rendered possible. Likewise, the life of a community of ants depends on the physiological aptitudes of the individuals of which it is composed. When cells are considered only as structural elements, they are deprived of all the properties that make them capable of organizing as a living whole. Within the organism, they are associated according to certain laws. Cell sociology results from properties specific to each cell type. Among these properties, some manifest themselves under ordinary conditions of life, while others remain hidden. Tissues are endowed with potentialities far greater than those which are apparent. But these potentialities become actualized only when certain modifications of the internal environment occur, as, for instance, when pathogenic agencies are at work within the body. The significance of a given structural state is bound to the knowledge of the corresponding physiological state. Structure and function must be considered simultaneously.

Thirdly, a tissue is evidently an enduring thing. Its functional and structural conditions become modified from moment to moment. Time is really the fourth dimension of living organisms. It enters as a part into the constitution of a tissue. Cell colonies, or organs, are events which progressively unfold themselves. They must be studied like history. A tissue consists of a society of complex organisms which does not respond in an instantaneous manner to the changes of the environment. It may oppose such changes for a long time before adapting itself to the new conditions through slight or profound transformations. To study it at only one instant of the duration is almost meaningless. The temporal extension of a tissue is as important as its spatial existence.

To summarize: The conception of the cells and of the tissues, which I propose to substitute for the classical one, is that of a system cells-environment, of which the structural, functional, physical, physicochemical and chemical conditions are considered in time as well as in space.

. . . .

The reconstruction of cytology, according to this conception, has required a radical transformation of the method. For this method only reaches the mental constructs that were considered as bei g the anatomical elements. Even when dealing with tissues still alive in the animal body or explanted *in vitro*, it remains confined to the realm of inanimate matter. The new method consists of a body of techniques through which the system cells-environment is apprehended in both its structural and functional aspects. It is based on the property of cells to remain alive *in vitro* when certain conditions are provided for them. There are two ways of preventing the death of tissues and organs removed from the organism. One was originated by Ludwig and the other by Harrison. Ludwig supplied the blood vessels of an excised organ with artificial circulation of a proper fluid. Thus he obtained the survival of glands for a number of hours. Although this procedure, more or less modified, has been used for a long time in many kinds of physiological experiments, it has remained too crude to allow entire organs to be cultivated *in vitro*. It seems, however, that parts of the body perfused with a nutrient fluid under proper conditions could be kept alive outside of the body for several weeks. By the combined use of the Rosenberger magnetic pump, of a respiratory chamber and of the aseptic techniques developed for the transplantation of organs and limbs, the old method of the physiologists of the nineteenth century is being rejuvenated, and may become one of the most useful tools of the new cytology. The second and simpler manner of keeping tissues alive *in vitro* is to reduce them to small fragments and, instead of utilizing the natural avenues of circulation, to feed them by diffusion from a nutritive medium brought into close contact with the cells. This technique was invented by Harrison more than twenty

years ago. Small portions of various tissues of the frog embryo were placed in a drop of lymph suspended over a hollow side. The lymph coagulated. During the following days, Harrison observed the formation of protoplasmic processes from the cells of the neural tube, and the differentiation of muscle fibers from the myotomes. Thus the truth of the histogenetic theory of nerve outgrowth was demonstrated, as well as the important fact that highly differentiated tissues can grow *in vitro* for several weeks. These admirable experiments, described in 1908 in a Harvey Lecture by Harrison himself, convinced me of the possibility of studying the effect of environment on cell multiplication in tissues growing *in vitro*. But from the early technique to the present method, the road has been very long. The original procedure of Harrison, although perfectly adapted to its purpose, did not allow the tissues to be maintained under constant conditions and their properties to be analyzed. Other and more powerful techniques had to be developed. This work required many years. Progressively, a number of procedures were elaborated which render possible the investigation of the relations of tissues and their environment.

The purpose of a first group of procedures is to obtain pure strains of the main cell types. Cytological as well as bacteriological studies must be made on cellular or bacterial colonies free from contamination by organisms of other types. The use of pure cultures is imperative. No reliable information can be gained from fragments of fresh tissues consisting of a heterogeneous mixture of cells. When the properties of a given cell type are under investigation, the colonies should be composed exclusively of cells belonging to this type. Such colonies are obtained either by mechanically isolating a group of cells which have migrated into the coagulum or by utilizing the selective effects of certain poisons, or of a proper diet, on cell multiplication. The species which have so far been isolated in a pure state are: tissue macrophages and fibroblasts (Carrel), cartilage cells (Fischer), iris epithelium (Fischer), blood macrophages (Carrel), thyroid epithelium (Ebeling), crystalline epithelium (Kirby), hepatic epithelium (Doljanski) and fibroblasts from cartilage, muscle, bone, etc., (Fischer, Doljanski, Parker). Several types of malignant cells have also been obtained in pure cultures: macrophages and fibroblasts of Rous sarcoma (Carrel), fibroblasts of sarcoma 10 of the Crocker Foundation and of Jensen sarcoma (Carrel), epithelium of Ehrlich carcinoma (Fischer), and epithelium of spontaneous cancers of the mouse (Carrel, Santesson). Most of these strains are capable of living indefinitely *in vitro*. The colonies are kept for experimental purposes just as bacterial strains are.

A second group of procedures has been developed for maintaining the tissues in media of unvarying composition. In the hanging drop technique, the medium undergoes profound changes from moment to moment under the influence of the tissue. Such marked variations are prevented by greatly increasing the volume of the medium relatively to that of the colony. The medium is contained in flasks where the tissues are effectively protected against bacterial infection. It is composed of three parts: solid, fluid and gaseous. The solid part is made of a fibrin coagulum, used by the cells as a scaffold. On its surface is placed the fluid medium containing the nutrient substances which reach the culture by diffusion. The proper physicochemical conditions, such as osmotic tension, H-ion concentration, etc., can be regulated at will. The gaseous atmosphere is made up of a mixture of oxygen, carbon dioxide and nitrogen, the proportions of which are varied according to the nature of the experiment. Since the fluid and gaseous media are several thousand times larger in volume than the tissues, they undergo only slight changes. When, after several days, these changes become noticeable, the fluid is removed, the coagulum washed with Tyrode solution, and a fresh nutrient medium added. If a larger amount of medium is needed, the apparatus of de Haan may be employed. A simpler way of circulating fluid at the surface of the tissues is to use flasks with lateral wings. These flasks are placed on an oscillating platform. At each oscillation, the fluid washes the surface of the coagulum, and prevents the local accumulation of catabolites. More elaborate culture chambers have been constructed in which the coagulum is covered by a thin stream of nutrient fluid. In this manner, a large volume of medium can be used without interfering with the respiration of the tissues. The changes that occur in the composition of the fluid and gaseous media are easily ascertained by ordinary chemical methods.

The techniques used for the preparation of the media form a third group. They consist of the ordinary physicochemical and chemical procedures. However, the chemical techniques differ slightly from the usual ones, because the substances must be handled under aseptic conditions and without being denatured (Baker). Many types of media are used: Tyrode solution and other saline solutions, blood serum, heparined plasma, juice of embryonic tissues, solutions of embryonic proteins, extract of bone marrow and of adult organs, proteins of different natures, products of the more or less complete hydrolysis of a number of animal and vegetal proteins, solutions of amino acids, nucleic acid, glycocoll, glutathione, hydrogen sulfide, sodium sulfide, hemoglobin, methemoglobin,

pepsin, erepsin, trypsin, peroxidase, catalase, ferments extracted from spleen, liver, muscle and from malignant tumors, lipoids from plasma and various organs, etc.

The structural and physiological conditions of the cell colonies are investigated by means of a fourth group of procedures, comprising the classical cytological and histological techniques with their recent acquisitions, and a series of newer physiological techniques. The measurement of the residual growth energy and of the rate of growth, and the estimation of oxygen, glucose, lactic acid, carbon dioxide, proteolytic ferments, protein split-products and other growth-activating substances used or produced by the tissues give some precise information about the physiological activities corresponding to a given morphological state. The response of the main cell types to various toxic and nutrient substances is also ascertained through the qualitative and quantitative variations of the colonies.

Cinematography was applied for the first time to the study of tissues living *in vitro* by Comandon. Later, Fabbri and Ebeling succeeded in filming the growth of pure cultures of fibroblasts. During the last six years, Ebeling and Rosenberger have systematically used this method in an investigation of the main cell types. Similar studies have been undertaken by Fischer, Canti and W. Lewis. Recently, the technique has been extremely simplified by certain mechanical devices invented by Rosenberger and by the fabrication of thin-walled flasks allowing the use of an immersion lens. When these flasks are employed, no special preparation of the tissues is necessary. The experiment to which the culture is subjected goes on without interruption while the microflask is placed in the apparatus and the behavior of the cells recorded as a routine procedure.

To summarize: Cytology, understood in the full meaning of the word, utilizes three groups of techniques: 1, ordinary chemical, physicochemical and physical techniques; 2, cytological and histological techniques; 3, physiological techniques that permit the isolation of pure strains of tissues and blood cells, and the study of the structural and functional characteristics of these cells while they live in media of known composition.

. . . .

It is with the help of this conception and of this method that a renovation of cytology and of histology has been attempted. This event is of recent date. The group of workers responsible for it is very small. The method has been used almost exclusively at the Rockefeller Institute and at the Kaiser Wilhelm Institute. So far, the studies have been confined to a limited number of cell types and to a few species of animals. Nevertheless, some fundamental properties of the tissues and of the internal environment have been discovered which classical histology completely ignored.

Tissue and blood cells are always in the process of becoming. They do not show their true physiognomy when they are examined under the microscope. Cinematography alone is capable of recording their fourth dimension. Fixed cells appear on the film as mobile as a flame. Their surface is never smooth. In some places, it bubbles like boiling water. Their body is composed of a fluid in which are suspended parts of a greater consistency, the nucleus and other organs. The nucleus, similar to an elastic ball, is surrounded by a belt of snake-like mitochondria which push it forward. Close to the nucleus and carried along with it by the cytoplasmic stream is a group of vesicles adherent to one another, resembling a bunch of grapes. They are the segregation apparatus of Renaut and the Golgi net. Through the anterior process, the cytoplasm seems to flow as a stream into the medium. Ameboid cells differ profoundly from fibroblasts and epithelium on account of the sharp definition of their surface and of their more rapid motion. The polymorphonuclear leucocytes are small and very agile amebas; the lymphocytes creep slowly like little worms; and the blood and tissue macrophages, which progress in an octopus-like manner, are surrounded by an almost invisible, undulating membrane. The folds of this membrane have the appearance of flagellate pseudopods.

Fixed and mobile cells, living outside of the body, always have a tendency to associate according to a pattern specific of the type. Fibroblasts organize in a matted tissue, where individual cells are in close but irregular contact. They never live as isolated units. A colony of fibroblasts looks like a dense crowd which moves without order. Very rarely do individuals wander far from the main group, which is composed of cells sliding upon one another in every direction. The colonies of epithelial cells associate in a more orderly manner. They can be compared to a regiment where each individual occupies an assigned place. Ameboid cells behave in quite a different way. They never form a tissue. They resemble a band of children scattering in every direction, with no other purpose than to run. While epithelial cells and fibroblasts aggregate in a tissue of limited dimensions, macrophages invade the entire medium at their disposal, as do bacteria. This tendency to retain a definite mode of colony formation persists in cells even after several years of life *in vitro*. However, the architecture of the colonies may be modified in some measure by the chemical composition of the medium. Under the influence of certain substances, macro-

phages form a matted tissue or assume the appearance of lymphocytes in a lymph node, or even flatten themselves like endothelium. Epithelial cells and fibroblasts may also wander away from the main colonies, as do macrophages. Nevertheless, their hereditary tendencies can always be recognized unless a change of the type itself has occurred.

Several important relations have been found to exist between the medium and the growth energy of a cell colony. First, the proliferative activity of a colony depends on the nature and the concentration of the substances contained in the pericellular fluid. Its resting condition is not due to its growth energy being kept under restraint by some unknown factor, but merely to the lack of proper food. Second, the substances that determine and support cell proliferation are chiefly embryonic proteins, plasma proteins and the larger split-products of certain proteins. Many other substances may stimulate cell proliferation without being able to support it. Third, in a given medium, each cell type shows a certain growth energy. This growth energy remains constant as long as the medium is not modified After nineteen years of life *in vitro* in embryonic juice, a strain of fibroblasts displays an unchanged rate of growth (Ebeling). Time has no effect upon a colony if the medium is constantly renewed. The aging of tissues results from the chemical changes which time imposes on the medium. A state of lower or higher growth energy can be produced at will by the introduction or the removal of proper substances in the pericellular fluid.

Tissues have the property of storing reserves when they live in a nutritive medium. The residual growth energy exhibited by a cell colony in a medium free from nitrogenous food expresses the presence of these reserves. The determination of its value has revealed marked differences in the aptitude of cell types to accumulate reserves at the expense of a given medium. This has led to the discovery of strains of fibroblasts which, although morphologically identical, differ in their nutritional properties. The food requirements of a given cell type are as fundamental a characteristic as its morphological aspect. It appears that each cell type demands a specific diet. Fibroblasts may multiply slowly in blood plasma (Fischer). They may also fail to multiply in such a medium, and ultimately die (Carrel, Ebeling). The explanation of this phenomenon is that fibroblasts, according to their origin, belong to different races characterized only by their food requirements (Parker). Some of these races proliferate slowly in plasma and remain for months in perfect condition, while others multiply still more slowly and degenerate very early. When embryonic juice and proteins, or hydrolysates of certain proteins, are placed in their medium, fibroblasts and epithelial cells always proliferate with great rapidity (Carrel, Ebeling, Baker). However, each type of fixed cells responds to these substances in its own way. The proliferation of fibroblasts in a given medium is always more rapid than that of epithelium. The food requirements of macrophages are quite different. These cells multiply very rapidly in blood plasma. They feed with great voracity upon fragments of fresh muscle or muscle killed by heat, protein precipitates, degenerated cells, etc. Substances such as embryonic juice, proteoses and peptones bring about their death at the concentration which is optimal for fibroblasts and epithelial cells. Nevertheless, at high dilutions, embryonic proteins and protein split-products cause a rapid proliferation of macrophages.

While the chemical conditions of the medium modify in this manner the growth energy of the colonies, they determine also important morphological changes. Two kinds of phenomena may occur: reversible changes in the form and dimensions of the cells and of their organs, or transformation of one cell type into another. Epithelium and fibroblasts, fed on embryonic juice, increase their volume. If proteoses are introduced into the medium, refractile granulations appear in the cytoplasm. The presence of serum produces large degeneration granules. Subjected to starvation in Tyrode solution, the cells and their organs decrease in size. Monocytes and macrophages are far more sensitive than fixed cells to the variations of the medium. A monocyte increases in size at least ten times when it is well fed. Pure plasma transforms macrophages into large cells surrounded by an undulating membrane and grouped like a thick undergrowth of bushes. The addition of amino peptones, sodium sulfide or enzymes from various organs, etc., may bring about the loss of the undulating membrane and the appearance of snake-like and fibroblastic forms, or the transformation of the mobile into mast-like cells. These changes are reversible. In a few days, the cells can be brought back to the state of macrophages with undulating membranes. When nitrogenous food is replaced by Tyrode solution, they grow smaller and revert to the dimensions of monocytes. Irreversible changes may be induced by certain media. During the digestion of their coagulum, macrophages that have been inoculated with extracts of Rous sarcoma transform into fibroblasts. Fibroblasts, treated with heparined plasma, may become macrophages. They acquire all the physiological properties of macrophages and remain indefinitely in that state.

The different cell types are also defined by the manner in which they modify their environment. Growth-promoting proteins, protein split-products, ferments, lactic acid, etc., may be detected in the

medium. Cell colonies growing in a semi-solid coagulum, where diffusion of the metabolites is slow, in some measure create their own environment. The medium adjacent to macrophages, thyroid or Ehrlich epithelium acquires new properties under the influence of the cell secretions. This indicates how various cell types act upon one another and contribute to the constitution of the local and general organic environments.

The isolation, in pure cultures, of a few strains of malignant cells has led to a simple method of investigating their nature. This method consists in comparing them with strains of normal cells of the same type from the point of view of their physiological and structural properties. At once the characteristics that cause malignant cells to differ from the normal ones become apparent. The macrophages of Rous sarcoma are diseased cells. They show many abnormalities, degenerate rapidly and are short lived. They possess the same food requirements as do normal macrophages, and their acid production is no greater. But they actively digest the fibrin of the coagulum, whereas this is not true of normal macrophages. The fibroblasts of sarcoma 10 of the Crocker Foundation, on the contrary, are healthy cells which never die. They resemble normal fibroblasts in their food requirements. But they differ from them because they digest the fibrin of the coagulum, produce more acid, and multiply rapidly in the presence of macrophages. The fibroblasts of Jensen sarcoma are also healthy cells. Although having food requirements similar to those of normal fibroblasts, they differ from them by their ability to multiply rapidly in blood serum and to digest the fibrin of the coagulum. The epithelial cells of Ehrlich carcinoma are diseased, like Rous macrophages, and very fragile. Even in pure cultures, they show structural irregularities, atypical mitoses, giant multinucleated cells, etc. They grow easily in rat serum, as do normal mammary gland cells. But unlike them, they invade fragments of embryonic tissue and digest the fibrin of the coagulum. The cells of the spontaneous mouse cancers differ in their properties from both normal and Ehrlich epitheliums. They liquefy fibrin and produce more acid than normal cells do. But they are generally deprived of the power to attack embryonic tissue and to feed upon it. Thus, it appears that the malignant types, which differ from one another in some aspects, have certain properties in common. They digest fibrin and feed upon substances or tissues which are not utilized to the same extent by normal cells. We may assume that *in vivo* they are malignant because they have the power of manufacturing from the neighboring tissues or interstitial lymph the nutrient substances which promote their unlimited proliferation. An important fact is thus brought to light: the mutability of certain cell types. Malignant cells are variants of the normal type. They differ slightly from it in some of their properties. These differences are not qualitative, but only quantitative. They are persistent. The cells do not revert to the original type even after years of cultivation *in vitro*. They are fixed variants, possibly analogous to those arising in microbic dissociation under the influence of several chemical substances and of the lytic principle of Twort.

The internal environment, which allows cells and tissues to manifest their life *in vivo*, consists of blood plasma, lymph and several varieties of interstitial fluids. While many of the chemical, physicochemical and physical conditions of blood plasma have been ascertained, especially through the studies of Van Slyke, Henderson, Haldane, du Noüy and others, the effect of these conditions on the main cellular types has not been investigated. In other words, the response of tissues to the organic medium and its constituents has remained almost entirely mysterious. Although we are still very far from knowing how this medium determines the functional activities and the differentiation of the main cell types, we have, however, brought to light some of its properties. Blood plasma supplies tissues with the substances they require for their growth. But it is not utilized in the same manner by the different cell types. Macrophages, as is well known, multiply actively in pure plasma, while epithelial cells and fibroblasts proliferate very slowly or not at all. Besides this nutrient effect, plasma possesses the characteristic of inhibiting the growth of connective tissue and epithelium. This property appears early in life, and increases rapidly with age in young animals, and more slowly in old animals. At the end of life, the inhibiting power of blood plasma is very marked. This growth-restraining property is due to the proteins and chiefly to the lipoids that it contains (Carrel, Ebeling, Baker). In certain pathological conditions, such as local infection, cachexia, etc., blood plasma also becomes inhibiting. It is probable that variations in the growth energy of tissues in function of age, as evidenced by the rate of cicatrization of a wound (du Noüy), or the residual growth energy of tissue (Carrel), can be attributed to such modifications of blood plasma. This growth-restraining effect can be partly counterbalanced, even in extreme old age, by embryonic proteins, protein split-products and leucocytic secretions. Therefore, a resumption of the proliferation of fixed cells is always possible *in vivo*. The cicatrization of a wound or the growth of a tumor occurs even in senile individuals. This inhibiting effect of plasma seems to be connected in some manner with cell differentiation. A pure strain of iris cells, treated with blood serum, decreases its rate of multiplication and manufactures large quantities

of black pigment. Important as these facts are, our knowledge of the internal environment is still in its infancy. The conditions of local organic media, that is, of the interstitial fluids of the tissues, have not as yet been discovered. We can assume that they resemble those of plasma, although modified by the products of cell activities. Each tissue or organ certainly manufactures in some measure its own medium, which, in its turn, acts on the cells. It is only through the analysis of the physicochemical and chemical conditions of the local medium that the state of a tissue *in vivo* can be completely understood.

. . . .

The success of the new method in bringing about the discovery of so many phenomena must be attributed to its power, which histology, physics and chemistry lack, to apprehend the complex system formed by the tissues and their environment. The concepts and methods of physics and chemistry are adapted to the atomic and molecular levels of the organization of matter. When applied to the cellular and supracellular levels, they detect only phenomena of the atomic and molecular orders. On the other hand, cytology and histology are concerned exclusively with the form of cellular and supracellular organisms. Therefore none of these sciences alone is capable of dealing with physiological phenomena, such as organization and adaptation, which belong to the supracellular order and are the expression of sociological laws. The laws specific of physiology, said Claude Bernard, are the laws of organization. Such are precisely the phenomena and the laws that the new cytology endeavors to discover by coordinating, through its own techniques, the data supplied about cells, tissues and organic fluids by physics, physical chemistry, chemistry and classical cytology and histology. Studied in this manner, cells and tissues appear as being endowed with properties which make them not only the building stones, but also the builders of an organism capable of developing, maturing, growing old, repairing wounds and resisting or succumbing to diseases. It is with such an aspect of the tissues that embryology and pathology, as well as cytology, should be concerned.

Experimental embryology, which searches for the mechanisms of the determination and differentiation of structures, may never completely fulfil its purpose unless its conception of cells and tissues, and its techniques, are modified. If embryonic parts were transplanted into media of known composition, instead of being grafted on a living body, it would be possible to ascertain how far development is dependent upon properties inherent in the cells themselves, and in what manner it is determined by the conditions of the pericellular fluid. Conversely, the transplantation of cell colonies into different parts of the body of the living embryo would reveal how the local internal environment may modify each cell type.

Although descriptions of the changes produced in cells and tissues by pathogenic factors fill many books, the mechanism and the significance of these changes remain practically unknown. This shortcoming must be attributed to the fact that cellular pathology, like histology, is based on an incomplete conception of the nature of tissues. The adaptation of the body to diseased conditions can not be understood as long as cells are conceived to be mere structural units. However, by taking into consideration the physiological properties of tissues as manifested under the influence of bacterial and other chemical changes in the organic medium, the doctrine of Virchow could be rejuvenated and extended to the whole field of pathology.

In the development of the new cytology, as in the development of every science, the conception is more important than the method. Techniques are only the servants of ideas. They have no great power in themselves. For this reason, the application to biological problems of the so called method of tissue culture by workers still clinging to classical cytology and histology has led to the confirmation of facts already known, but not to any real discoveries. A method is an instrument which finds only that which is being sought. The new cytology is considering cells and tissues, not only as elements of the dead body, but as living beings which are themselves parts of organisms of a more complex order. With the help of the auxiliary sciences of physiology, it is progressively discovering the properties which make these cells and tissues the structural and functional units of an harmonious whole.

THE ADVANCEMENT OF HORTICULTURAL RESEARCH[1]

By Professor A. T. ERWIN

IOWA STATE COLLEGE

HORTICULTURE is both a science and an art. Its applications as an art long preceded its development as a science. The hardening off of plants was practiced for years before the notable studies of Whitten, Rosa and others dealing with sap densities, etc., were made. Chandler rather uniquely expresses the situa-

[1] Presidential address before the American Society of Horticultural Science.

tion thus: "It is probable that, more often than otherwise, when a discovery is made that explains in a fundamental way some response of the tree, we shall look, not forward to its application, but backward to find it already in practice." That research in horticulture should catch up, so to speak, and take a position in the advance guard and open the way for new applications goes without saying. May I offer two or three suggestions which, it seems to me, might in some measure contribute to this end.

Obviously, there can be no research without a researcher. The content of horticultural courses, and the training of research workers in this field, is a subject within itself. However, in passing I would like to raise this inquiry: As horticulturists, should we not lay greater emphasis upon the necessity of building up an adequate background and the development of a perspective, as the first step in an investigation? The acquirement of skill in searching out the literature of horticulture and related sciences as a means to this end is obviously a necessary corollary. A survey among employers of chemists brought forth the criticism that college graduates do not know how to use a library. Perhaps the criticism might have gone one step further and raised the question as to whether a college training develops within the student the inclination and incentive to use the library. Does the average student leave the campus with the feeling that he has completed his education or with the realization that it has only begun? I am beginning to wonder if we have not all sinned more or less in digesting material for the student (I refer to upper classmen and graduates) instead of requiring them to ferret it out for themselves and thus acquire the library habit. It was Bishop who said, "It is only by a combination of the historical and the experimental method that any work of first-rate importance can be produced in any field of knowledge."

Progress in any field of science is dependent upon the new worker beginning where the last one left off. "Failure to build upon the past," says Dr. True, "frequently means aimless wandering about in fields previously explored. The preparation of a bibliography at the beginning of a new project affords a knowledge of the field and also serves as a guide to the possibilities of further research."

The growth of research work, in the various fields of plant investigation, has been so great that a literary survey is sure to bring the worker in touch with new sources of information and new angles of approach to his particular problem. Crane says, "Literature is the foundation of every scientific inquiry of importance." A prominent manufacturing firm expended one thousand dollars on a certain experiment. A satisfactory product was obtained, upon which they applied for a patent. Much to their pain and surprise they learned that this particular field had already been rather completely explored and that a number of patents had been granted previously. Probably few station workers know anything about such generous allotment of funds for a single project, yet the incident does enforce the need of a complete survey of the literature of a particular field before proceeding with the investigational work in the laboratory. Some one has said that every monkey has to start his investigations where his father did; consequently, there is no advance of knowledge in monkeydom.

This subject has another important aspect. There is a serious need for more direct means of access to the literature of horticulture. From the various state experiment stations and related organizations there is an enormous volume of material, much of which is accessible to the research worker only at the expense of an endless amount of time and energy. Considerable progress has been made in the way of providing working tools for access to the literature, such as reviews, digests and indices, and yet an impartial survey of the field will, I believe, bring forth the verdict that the literature of agriculture is inadequately equipped with these facilities as compared with the field of engineering, for example, and that we are lagging behind in this respect.

The *Experiment Station Record* provides well-written digests of station publications. The reviews affecting horticultural crops, however, are spread among the editorial departments of agricultural botany, field crops, horticulture, genetics, soils, and fertilizers and entomology. Since the same subject is handled in different departments in different institutions, the identical subject-matter may be reviewed in any one of the above-named editorial departments. As a consequence there is no definite guide as to where to turn for the information desired, and the result is that it is necessary to review the literature of all of these departments for a given topic. From the view-point of a crops specialist a topical classification in the *Experiment Station Record* would have many advantages. Under this arrangement all of the reviews relating to apples, for example, would be classified under that crop as the unit. Possibly the specialist in other than crop fields would prefer the present arrangement. It would seem that a topical and authors' index to each number would solve the problem. Since this has to be done anyway at the end of the year, it would mean only a slight expense to provide a cumulative index with each number as is done with the Agricultural Index, for example.

The Cumulative Indices of the *Experiment Station Record* is a valuable source of reference. The last

number, however, was issued in 1919; consequently it is eleven years behind.

Agricultural Index covers a comprehensive digest of a selected list of agricultural periodicals and bulletins from 1916 to date, and the indices are cumulative by quarters. Many of the articles reviewed are popular in character and this publication serves the general reader rather than the research worker.

The U. S. Department of Agriculture published a topical card index of the literature of the experiment stations and kindred institutions. This was discontinued in 1916, so that it is now fourteen years out of date; it also lacks an authors' index.

The U. S. Department of Agriculture also maintains a card index of the publications of the federal department which is complete and up-to-date, both as to subjects and author. The federal department also publishes at intervals a list of bulletins of experiment stations.

Biographical Abstracts is an invaluable source of information but contains no indices for any of its volumes.[2]

In contrast with this situation, in the field of engineering and chemical literature we find available a complete card catalog both as to author and subject and with numerous cross references. Some one has said that the card catalog is the master key to a library. The point I am trying to make is that there is a vast field of agricultural literature for which this key is lacking, and the situation is one which seriously retards horticultural research. The card catalog of experiment station literature referred to above would serve as an excellent nucleus for such a program but is too far out of date to be more than a starting point, as it is. In some fields, as genetics for example, most important concepts have been presented during the past decade.

I am sure that we can all testify to the fact that librarians as a class are ambitious to serve every field of science, including agriculture, and stand ready to cooperate with other departments, but with limited funds they naturally respond to the calls from the fields where there seems to be the greatest interest, so perhaps one way of remedying this situation is for us as horticulturists to get behind a library program and make it a more significant factor in our teaching and research work. The interest and support of the department heads in behalf of more adequate appropriations for library work would, no doubt, also help.

The particular problem of classifying and making accessible, through a card catalog, the vast body of experiment station literature is obviously an appropriate federal activity and probably hinges on the matter of funds. If so, the members of this society might here lend a helping hand. Aside from the experiment station literature, the proceedings of this society affords a most important source of information. A complete card index by title and author of its proceedings would be of great value to every state college library. Completion of the card catalogue, dropped by the federal department fourteen years ago, might well include this class of literature. A card catalogue of experiment station literature similar in character that is now available for the publications of the U. S. D. A. would prove valuable to station workers. The federal government has invested large sums in these investigations and a modest sum to make the reports of these results accessible would surely be a logical program.

May I now turn from the matter of library facilities to the subject of research projects. The accumulation of reliable data on field crops requires both a consecutive effort toward a definite objective and a considerable period of time for its execution. The objective remains the same from year to year, but the method of procedure may require revision. I need only mention the modern concepts of sweet corn breeding, as compared with the ear to row method of a decade ago, as an example. Without any thought of hastening a project to a premature conclusion, a complete and thorough review of all station projects by a capable, broad-minded committee, in conference with the chief and project leader may prove very helpful. Such a review made in a critical yet sympathetic spirit may bring to the leader new avenues of approach to his problem and liberate him from some conventional methods to which he has become wedded. Such a project review may also bring to light unproductive activities, the continuance of which means only a waste of time and money.

This review is also apt to result in a revision of project outlines. With a refinement of methods the very term, project, has taken on a new meaning. This new view-point is concisely expressed in an address by Dean R. E. Buchanan before the Association of Land Grant Colleges, from which I quote: "The ultimate division of research, the particular thing upon which the member of the staff is working, we call a project. Related projects may be grouped into larger units called a program. Related programs may be grouped into a field." The trend is therefore definitely in the direction of projects, being more concrete with a more direct approach, a more clearly specified goal and a title as informative and explicit as possible. This results in the elimination of certain factors and simplifies the interpretation of the resulting data. With a more limited objective and a more direct attack the project will probably be less protracted, though I do not think this should be the point of emphasis. A review of experiment station

[2] The Index to Volume 1 has appeared since this was written.

literature along most any crops line will, I believe, justify the assertion that more sins have been committed from premature publication than from over-conservatism in this regard.

A review of activities in the light of the term project, as above defined, may also lead to the conclusion that many of our listed projects are in reality programs, any one of which being divided into its component and restated means several projects. To cite an example in our own institution, sweet corn breeding is one of the major projects of the Vegetable Crops Section. The first step is, of course, the development of homozygous lines, and second, that of crossing. As restated we now have two projects; one, the development of homozygous lines of specified varieties of sweet corn, and the second the crossing of these lines for certain specified objectives.

The growth of the extension movement is probably the outstanding characteristic of our agricultural history of the past quarter of a century. It carries to the great body of farmers the results of the experiment station and is an activity of inestimable value. It has, however, greatly stimulated inquiry on the part of the grower, and as a result many station workers are deluged with a large volume of inquiries, which makes a heavy drain of both time and money upon the field of research for an activity which is clearly not research in character. Every institution should welcome the opportunity to serve in this way, but the service belongs to the field of extension rather than research. There is need of the heartiest cooperation between the extension worker and the station staff in answering certain inquiries of a technical character. There are also instances where it is an advantage for the station worker to keep in touch with his constituency in some particular territory where he is dealing directly with a project, the outcome of which is of interest to both the grower and the station. To the extension service also belongs the miscellaneous testing of seeds and other work of a similar character; a useful service, but not a research activity.

As a closing sentiment may I quote, "The spirit of research is Devotion to Truth and an insistent Longing for Better Understanding." In that spirit, let us press forward and meet the challenge of the new year.

SCIENTIFIC EVENTS

INTERNATIONAL MEETINGS IN ENGLAND[1]

THE jubilee celebrations of the Society of Chemical Industry, it has been announced, will be of a domestic character, the functions being thrown open only to members and a very few distinguished guests who will be the recipients of special honors. The society was founded in 1881, and to-day has upwards of 7,000 members, associate members and subscribers. The meetings will commence on July 13 and will extend over the succeeding seven days. It is hoped the Lord Mayor of London will open the proceedings by receiving the delegates at the Guildhall, and succeeding events will include the annual dinner, the annual general meeting, the delivery of the presidential address, and the presentation of the society's medal. Visits to many works typical of the manufactures of London are being arranged; the Chemical Engineering Group of the society is arranging an exhibit of special recording and measuring instruments in the Central Hall, Westminster, where there will also be an exhibit of British chemical plants arranged by the British Chemical Plant Manufacturers' Association. To mark the occasion permanently, Dr. Stephen Miall, editor of *Chemistry and Industry,* is writing a history of the chemical industry, to be published at a low cost immediately prior to the meeting, and a special jubilee number of the *Journal* of the society will be published containing reprints of outstanding papers, biographies of presidents, medallists and honorary members, and a history of the society. While the preliminary program was being arranged, the late Lord Melchett held the presidency of the society, but he has now been succeeded by Sir Harry McGowan. The headquarters of the society are at Central House, 46 Finsbury Square, E.C.2, Mr. H. J. Pooley being the general secretary.

The meeting of the International Illumination Congress, the ninth of its kind, will be divided into two parts, the first part consisting of a congress which will be held from September 2 to 12, and the second part consisting of meetings of the technical committees of the International Commission on Illumination, to be held from September 13 to 19. The congress, of which Mr. C. C. Paterson is the president, is being organized by the National Illumination Committee of Great Britain, in cooperation with the Illuminating Engineering Society, 32 Victoria Street, S.W.1, Colonel C. H. S. Evans being the honorary general secretary. After assembling in London on September 1 to 3, the delegates will then spend two days at Glasgow, three days at Edinburgh, two at Sheffield, two at Birmingham, and the remainder of the time, from September 13 to 19, at Cambridge. At the latter place will be held the plenary session of the International Commission on Illumination. A comprehensive list of subjects for discussion has been drawn up, and papers will be presented on the lighting of factories, offices,

[1] From *Nature.*

houses, vehicles, streets, museums and lighting for traffic control, together with others on lighting for aviation and navigation, flood lighting, architectural lighting, laboratory technique and the lighting of mines. Many institutions are represented in the general council of the congress, the chairman of which is Lieutenant-Colonel K. Edgcumbe. The first three International Illumination Congresses were held at Zurich, and the others have since been held at Berlin, Paris, Geneva, Bellagio and Saranac, New York.

THE FIFTEENTH INTERNATIONAL CONGRESS OF AGRICULTURE

WORLD agricultural policies with a view to organizing agricultural production in different countries so as to equalize the supply with the demand for farm products will be considered at the fifteenth International Congress of Agriculture at Prague, which meets from June 5 to 8. Ninety-two national agricultural associations from twenty-seven countries will participate in this congress to be held under the auspices of the International Commission of Agriculture.

Professor Dr. Ing. Vlad. Brdlik, president of the organization committee, has asked the U. S. Department of Agriculture to bring the congress to the attention of agricultural scientists and leaders in this country. The department has acquiesced in this request and suggests that American agriculturalists who may be traveling in Europe at the time of the congress will find it to their advantage to include Prague in their itineraries. The congresses are held every two years in different countries, under the auspices of the governments of the countries in which they are held.

The program this year is separated into seven sections entitled agrarian policies and rural economy; agricultural education and extension; agricultural cooperation; vegetable production; animal production; agricultural industries, and "the rural woman."

The section on agrarian policies and rural economy will consider the possibilities of organizing agricultural production in different countries with a view to bringing about an equilibrium between supply and demand of agricultural products, and in what measure and by what means the expenses of production may be decreased. The importance and possibility of research on the formation and forecasting of agricultural prices will also be considered.

The section on agricultural education and extension will consider services of agricultural consultations on an individual basis; methods employed and results obtained, and modern methods for promoting progress in rural districts by means of radio, motion pictures, agricultural expositions and other agencies for making known the results of research. The section on agricultural cooperation will consider education in cooperation, the means employed and results obtained. The section on vegetable production will consider national and international legal protection of new plant production and the actual status of the question of inoculating the soil.

The section on animal production will consider heredity and its control in individual animals in order to improve their economic yield, and the possibilities of raising fur-bearing animals in connection with farming. The section on agricultural industries will consider methods and importance of the industrial utilization and conservation of potatoes and other vegetables. The mission of the woman in the struggle against the rural exodus will be the principal topic of the section on the rural woman. The feeding of the farm family by means of products grown on the farm will also be considered by this section.

THE PASADENA MEETING

PLANS for the Pasadena meeting are now well under way. The main features follow rather closely the precedent set by the British Association for the Advancement of Science. These are (1) meetings extending through a full week, June 15–20, (2) emphasis on symposia, (3) scientific sessions in the morning only, (4) afternoons devoted entirely to opportunities for discussion and personal contact through large numbers of excursions, and (5) popular addresses each evening by speakers of national and international reputation.

Professor Thomas Hunt Morgan, retiring president, and Professor Franz Boas, newly elected president of the association, both expect to attend the meeting.

Astronomy (Section D) will be well represented in the program, since the Astronomical Society of the Pacific, a very strong affiliated society, will meet with the association at Pasadena. Tentative plans call for three morning sessions, and a fourth if the number of papers requires it. One of these sessions will be devoted to invited papers on "Problems of the Two-Hundred-Inch Telescope" and "The Physical Interpretation of Stellar Spectra." A list of other societies which will meet with the association is given in SCIENCE for February 27.

Dr. Hale's spectroheliosocope will be available for the actual use of visitors, the treasures of the Huntington Library and Art Gallery will be shown, Kennedy's repetition of the Michelson-Morley experiment, the 100-inch telescope, the 1,000,000-volt laboratory and its giant x-ray tube, will all probably be available.

Special round-trip rates will be offered by the railways. For example, the round-trip rate (out and back over different lines) from New York will be approximately $140, from Chicago $90.

CHARLES F. ROOS,
Permanent Secretary

FELLOWSHIP IN MEMORY OF JAY BACKUS WOODWORTH

A Jay Backus Woodworth graduate fellowship in geology has been completed to a total of $25,-009.98, by contributions from 85 persons, mostly former students of Professor Woodworth at Harvard. The committee consisted of Richard M. Field, Edward Mallinckrodt, Jr., Charles Palache, Thorndike Saville, R. W. Sayles, T. Wayland Vaughan, Robert DeC. Ward, Edward Wigglesworth and Charles F. Brooks, *chairman*.

It is the hope of the committee that the first award of this fellowship may be made for the coming academic year, even though the accumulated income by that date will not equal the full amount to be expected in later years.

The fellowship is in memory of Jay Backus Woodworth, distinguished Harvard seismologist, who died in 1925. Owing to Professor Woodworth's broad interest in the whole field of geology, the award of this fellowship is not to be restricted to any one phase of the science.

In the letter of gift to President Lowell, the committee expressed preference to have this fund used according to the following conditions:

On the recommendation of the division of geology of Harvard University, or of such other body as may succeed to the functions of this division, the income of this fund is to be appropriated from time to time as a graduate fellowship in geology, preference being given to a candidate who has shown decided capacity in the pursuit of geology and good promise of advancing the science. However, if future conditions should be such that the foregoing directions can not be followed to advantage, the disposal of the income shall, by vote of the division of geology, or of such other body or bodies as may succeed to the functions of this division, with the approval of the corporation, be otherwise made in the interests of geological research or higher training in geology.

AWARD OF THE LEIDY MEDAL OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

The Academy of Natural Sciences of Philadelphia announces the selection of Dr. William Morton Wheeler, professor of entomology at Harvard University and dean of the Bussey Institution for Applied Biology, as the recipient of the third Joseph Leidy Memorial Award. Dr. Wheeler was selected "in recognition of his comprehensive and exhaustive studies of the ants of the world, their structure, classification, social organization and behavior; his equally noteworthy contributions to our knowledge of animal psychology, and analyses of evolutionary processes."

The Joseph Leidy Memorial Award was founded in 1923, and consists of a bronze medal and honorarium, given every third year, "as a reward for the best publication, exploration, discovery or research in the natural sciences in such particular branches thereof as may be designated." The selection of the recipient of the award is placed in the hands of a committee of the academy, which body also determines the fields of activity to be considered.

The first award of the Leidy Medal was made in 1925 to Dr. Herbert Spencer Jennings, of the Johns Hopkins University, for his researches upon the Protozoa and the Rotatoria. The second award, in 1928, was made to Dr. Henry A. Pilsbry, curator of mollusks of the Academy of Natural Sciences of Philadelphia, in recognition of his researches upon the phylogeny of the terrestrial mollusca, and his work on the classification of the Cirripedia.

The committee on the Joseph Leidy Award for 1931 was composed of Dr. Witmer Stone, chairman, Mr. Childs Frick, Dr. Thomas Barbour, Dr. Herbert Spencer Jennings and Mr. James A. G. Rehn.

The award will be formally presented to Dr. Wheeler at the meeting of the academy to be held on April 21.

SCIENTIFIC NOTES AND NEWS

On the occasion of the commemoration of the one hundred and fiftieth anniversary of the Manchester Literary and Philosophical Society on March 17, Sir J. J. Thomson made the address and the Dalton Medal was presented to him.

Presiding at the convocation of Calcutta University, Sir Stanley Jackson, the governor of Bengal, presented the Hughes Medal of the Royal Society to Sir C. V. Raman, who was recently awarded the Nobel Prize in physics.

The Bessemer Gold Medal of the British Iron and Steel Institute has been awarded this year to Sir Harold Carpenter, professor of metallurgy in the Royal School of Mines, Imperial College of Science and Technology, London, in recognition of distinguished services in the advancement of metallurgical science.

Dr. John Alexander Low Waddell, consulting engineer of New York City, was presented with the first award of the Clausen Gold Medal, "for distinguished service to the engineering profession in the field of welfare," at a dinner of the American Association of Engineers on March 12. Mr. James H. Griffin, president of the association, made the presen-

tation. Dr. David B. Steinman, consulting engineer, served as toastmaster. Other speakers included G. M. Butler, dean of the College of Mines and Engineering of the University of Arizona, and Francis H. Sisson, vice-president of the Guaranty Trust Company.

DR. ROY CHAPMAN ANDREWS, of the American Museum of Natural History, was on March 13 awarded the Hubbard Gold Medal by the National Geographic Society for his geographical discoveries in Central Asia. Dr. Andrews, who discovered fossils of nearly a hundred species of prehistoric animals in the Gobi desert, will be the ninth man to receive the medal, the highest honor the society bestows. The medal was presented by Dr. Gilbert Grosvenor, president of the society.

CAPTAIN SIR GEORGE HUBERT WILKINS, who took the remodeled navy submarine *0–12* on its trial run on March 16, in preparation for his underseas Polar trip, received the Elisha Kent Kane Medal from the Geographical Society of Philadelphia on March 11 for "outstanding achievement in exploration." The medal was awarded at the society's annual dinner. Sir Hubert was the principal speaker. Dr. Roy Chapman Andrews was the recipient of the medal two years ago, and Rear Admiral Richard E. Byrd received it in 1927.

THE *Journal* of the American Medical Association reports that Dr. John Chalmers Da Costa, Samuel D. Gross professor of surgery, Jefferson Medical College, delivered a lecture reviewing his forty years' active work in surgery as the principal feature of the first observance of Da Costa Day by the Philadelphia County Medical Society on March 11. There was an attendance of over one thousand. Da Costa Day was inaugurated last year with the establishment of the John Chalmers Da Costa Foundation for the purpose of furthering postgraduate teaching under the auspices of the society.

DR. GEORGE W. CRILE, head of the Cleveland Clinic and professor emeritus of surgery at Western Reserve University School of Medicine, was the guest of honor at a dinner given by about 400 physicians on February 23. Dr. Charles H. Mayo was the principal speaker.

DR. WALTER LAWRENCE BIERRING, Des Moines, for many years secretary of the Federation of Medical Boards of the United States, was the guest of honor at a dinner given by the Des Moines Medical Library Club on March 7.

THE William H. Nichols Medal of the New York section of the American Chemical Society for 1931 was presented on March 13 at the Engineering Societies Building to Dr. John Arthur Wilson, of Milwaukee, "for outstanding achievement in colloid chemistry, applied particularly to leather and sanitation." The presentation was made by Dr. J. G. Davidson, of the Carbide and Carbon Chemicals Corporation, chairman of the jury of award and past president of the New York section. D. P. Morgan, Jr., secretary of the section, read an address by Dr. Clarke E. Davis, production manager of the National Biscuit Company, on the life of the medalist, and Professor Arthur W. Thomas, of Columbia University, spoke on the recipient's scientific accomplishments. Professor Arthur E. Hill, of New York University, chairman of the section, presided. Dr. Wilson responded with an address on "Leather, Sanitation and Colloid Chemistry."

AT the annual meeting of the American Society of Naturalists in Cleveland, Dr. J. Playfair McMurrich, professor of anatomy at the University of Toronto, was elected an honorary member of the society. The American Society of Naturalists was founded in 1883, and Dr. McMurrich has been a member since 1884. He was president at the Chicago meeting in 1907 and has served the society from time to time in various other capacities.

THE title of "professor emeritus" has been conferred upon Dr. Walter Ramsden, who resigned from the Johnstone chair of biochemistry at the University of Liverpool last December.

DR. HOWARD MCCLENAHAN, secretary of the Franklin Institute, Philadelphia, has been elected to the council of the American Association of Museums. Dr. McClenahan fills the vacancy created by the resignation of Mr. Waldemar Kaempffert, who is leaving the directorship of the Museum of Science and Industry at Chicago to become a member of the staff of the New York *Times*.

DR. LOUIS I. HARRIS, who resigned as health commissioner of New York City to become health expert for the National Dairy Products Corporation, has dissociated himself from the latter corporation.

AFTER serving for more than ten years as secretary-treasurer of the New York State Forestry Association, James R. Simmons resigned his position on March 5. John C. Sammi, instructor in the department of engineering at the New York State College of Forestry, has been appointed temporarily to fill the office vacated by Mr. Simmons.

DR. J. ROSSLYN EARP, lecturer in the University of Colorado, has been appointed director of the bureau of public welfare of New Mexico, succeeding Dr. George Sparr Luckett, who resigned several months ago.

MR. HAROLD J. COOK, curator of paleontology in the Colorado Museum of Natural History, Denver, is resigning from the active staff of the museum to give full time to private affairs and to the active development of the Cook Museum of Natural History at Agate, Nebraska.

CAPTAIN W. P. B. BEAL, formerly principal veterinary officer of the Gold Coast, has been appointed superintendent of the new zoological park of the Zoological Society of London at Whipsnade. It is expected that the park will be opened this spring.

DR. WILLIAM W. CORT, professor of helminthology in the Johns Hopkins Medical School, and Dr. George E. Nichols, professor of botany and director of the Marsh Botanical Garden of Yale University, will during the coming summer be members of the staff of the Douglas Lake Biological Station of the University of Michigan.

PROFESSOR HENRY B. BIGELOW, of Harvard University, scientific adviser to the International Ice Patrol, sailed on March 11 for Copenhagen to attend the conference of the International Council for the Exploration of the Sea, to be held from March 23 to 30.

DR. ALBERT W. HERRE, curator of the zoological museum of Stanford University, left on March 9 for an extended collecting tour among the islands about the Sulu and Celebes Seas. From Mindanao and Borneo he plans to go to Canton, China, to collect fishes in that region.

DR. J. HENDERSON SMITH, in charge of the plant virus disease research at the Rothamsted Experimental Station, Harpenden, England, is at present making an extended tour of the botanical institutions of America in relation to his investigations in plant pathology. On March 9 he gave an illustrated lecture with motion pictures on "Intracellular Inclusions in Plant Virus Diseases" before the department of botany of Columbia University, under the auspices of the Institute of Arts and Sciences of that institution.

PROFESSOR RICHARD COURANT, of the University of Göttingen, will join the faculty of the University of California at Berkeley for the summer session of 1932. Professor Paul S. Epstein, of the California Institute of Technology, Pasadena, will arrange for lectures at other institutions by Professor Courant during the spring of 1932.

DR. DONALD H. ANDREWS, of the department of chemistry of the Johns Hopkins University, recently gave a series of three lectures at the University of Minnesota on: "Seeing Inside the Molecule"; "Thermal Energy in Organic Molecules," and "The Leiden Low Temperature Laboratory."

THE annual meeting of the Illinois State Academy of Science will be held in Peoria on May 8 and 9 under the presidency of Dr. Fred R. Jelliff. The general program of the forenoon of May 8 will consist of addresses by Dr. William Hoskins, of Chicago; Dr. T. R. Hogness, of the University of Chicago, and Dr. A. C. Ivy, of Northwestern University, on various phases of chemical development, while the addresses that evening will be by President H. W. Chase, of the University of Illinois, and by Dr. Francis G. Blair, state superintendent of public instruction. The afternoon of the eighth will be devoted to sectional meetings. On Friday the Junior State Academy will also meet and will have its own program. Saturday will be largely given over to field trips.

THE Kansas Academy of Science will hold its sixty-third annual meeting at the University of Kansas on April 24 and 25. General papers and business will occupy the forenoons while the afternoons will be devoted to sectional programs in biology, entomology, physics, chemistry and psychology. A banquet will be held in the evening of April 24 and will be followed by the address of the president, Dr. Hazel E. Branch, of the University of Wichita. Later in the evening there will be a public address. Scientific men of neighboring states are cordially invited to attend the sessions of the academy and may appear on the program if they will send their titles of papers to the secretary, Dr. George E. Johnson, at the Kansas State Agricultural College, Manhattan, Kansas.

THE monthly meeting of the Torrey Botanical Society of America, held on March 3 at the department of botany of Columbia University, was devoted to demonstrations and methods of biological teaching in high schools and undergraduate colleges. More than a hundred exhibits and demonstrations ranging from elementary biology, mycology, medical and plant pathology, morphology and physiology illustrating favorable materials and methods for teaching had been set up for the occasion. This meeting also marked the official opening of the new quarters of the department of botany at Columbia University.

THE fourth annual meeting of the Texas Entomological Society was held on March 9 in San Antonio, Texas. This organization is unique in that it is composed of seventy-five members, each one of which holds either a federal or state entomological position. A very full program was given consisting of papers reporting upon original research or progress made on field control of economic insects. Resolutions were passed supporting the bill for a state museum now before the legislature; providing for a committee to formulate a bill providing for laws regulating the

sale of insecticides, vermifuges and fungicides, and to provide for licensing firms attempting to put on campaigns against insects. Action was taken completing the affiliation of the Texas Entomological Society with the Texas Academy of Science. A committee was provided to plan for the erecting of a memorial to Belfrage, the pioneer Texas entomologist. S. W. Bilsing, M. A. Stewart and F. L. Thomas were reelected as president, secretary-treasurer and vice-president. A feature of the program was a visit to the U. S. Pink Boll Worm Laboratory, where Mr. R. E. McDonald, who is in charge of this work, conducted the party through the laboratory and explained the work of the collection of something more than a million cans of cotton bolls from all districts of the United States and of their subsequent examination for the pink boll worm.

THE American Public Health Association announces that its sixtieth annual meeting will be held in Montreal from September 14 to 17, with the Windsor Hotel as headquarters. The association has not held a meeting in Canada since 1908 and public health workers from the Dominion and from the United States are invited to take advantage of this opportunity for closer contact. The program is being planned with the progress and needs of both countries in mind. Such subjects as toxoid immunization; rural sanitation, particularly the organization of a practical program for county health units; health education for a large city, for a small city, and for a rural community; camp and resort sanitation, including fungus skin infections, particularly those transmitted in swimming pools, and general sanitation of auto camps, have been considered so important by the program committee that special sessions will be devoted to them. Each section of the association will arrange individual programs, covering public health administration, laboratory research, vital statistics, public health engineering, food, drugs and nutrition, child hygiene, public health nursing, health education, epidemiology and industrial hygiene. Meetings of four other organizations, the American Association of School Physicians, the Conference of State Sanitary Engineers, the International Society of Medical Officers of Health, and the International Association of Dairy and Milk Inspectors—will take place during or immediately preceding the sessions of the association. For further information address the American Public Health Association, 450 Seventh Avenue, New York, N. Y.

THE California Academy of Sciences announces a special course of four free public lectures on the general subject, "The Beauties of Nature and the Forces Which Have Had to Do with Making This World the Interesting and Beautiful World That It Is." The lectures, which will be given on the evenings of April 1, 8, 15 and 22, are: "The Growth of the Earth as an Abode of Land Life," by Dr. Bailey Willis, professor emeritus of geology, Stanford University. "The Age of the Earth as Taught by the Grand Canyon of the Colorado," by Dr. William Morris Davis, professor emeritus of geology, Harvard University. "The Origin and Development of Land Plants," by Dr. Douglas Houghton Campbell, professor emeritus of botany, Stanford University. "The Origin, Distribution and History of the Giant Sequoias, the Oldest Living Things in the World," by Dr. Willis Linn Jepson, professor of botany, University of California.

THE Second International Congress of Linguists will meet at Geneva From August 25 to 29, 1931. The first congress was held from April 10 to 15, 1928, at La Haye. Those interested in the congress should communicate with M. Albert Sechehaye, Rue de l'Université 5, Geneva, Switzerland.

THE American School of Prehistoric Research, jointly with the British School of Archeology at Jerusalem, will begin on April 1 excavations at the foot of Mount Carmel, near Athlit, Palestine. Work will be carried on simultaneously at two caves in the Wady el Mughara and at another site near by. Miss Dorothy Garrod, of the British School, will be in charge. The eleventh annual summer session of the American School of Prehistoric Research will open in London on July 1. Dr. V. J. Fewkes, of the University of Pennsylvania, will be in charge. The itinerary includes London, East Anglia, Paris, Brittany, Charente, Dordogne, the Pyrenees, Lyons, Neuchâtel, Zurich, Vienna, Budapest, Bratislava, Brno and Prague. The rest of the term, from August 1 to September 16, will be devoted to excavations at Homolka, near Prague. It is also planned to have a second group of students for a shorter term (July 1 to August 1) and a less intensive program. Further information may be obtained from Professor George Grant MacCurdy, Peabody Museum, New Haven, Connecticut.

ON March 5 the governor of Kansas approved a bill changing the name of Kansas State Agricultural College to Kansas State College of Agriculture and Applied Science. The adoption of the more inclusive name is said not to involve or imply any change in the aims, character or work of the college.

THE *Journal* of the American Medical Association says: "When the University of Southern California Medical School was first opened the dean was enabled to secure a corps of well-qualified teachers, under the belief that other needed improvements would be made. For that reason, at a business meeting of the Council on Medical Education and Hos-

pitals of the American Medical Association held in June, 1930, the council voted that an acceptable rating be granted for the students who had completed their first two years of medical work during the years 1928–1929 and 1929–1930 under the faculty thus secured, but that an acceptable rating for the medical school be withheld in the hope that further improvements deemed essential would be made. Recent information obtained from reliable sources, however, indicated that, instead of making further improvements, actually retrogressive measures had been adopted. At a business meeting of the council held on February 15, therefore, the council had no other alternative than to vote that an acceptable status for this medical school be not granted."

It is announced that a school of medicine will be organized as a part of the Louisiana State University. Premedical work and the first two years for the medical work will be given at Baton Rouge, and the last two years will be given in connection with the Charity Hospital at New Orleans. Dr. Arthur A. Vidrine, superintendent of Charity Hospital, has been named dean.

The U. S. Civil Service Commission announces the following competitive examinations: physicist, at $3,800 a year, associate physicist, $3,200, and assistant physicist, $2,600. The optional subjects are: Heat, electricity, mechanics, light, radio, physical metallurgy, thermodynamics and aerodynamics, and any specialized work in the field of physics not included in any of the above. Applications for these positions must be on file not later than March 25. The examinations are to fill vacancies in the Bureau of Standards and Bureau of Mines, and under the National Advisory Committee for Aeronautics. Applications for the position of park historian, $3,800 to $4,600 a year, associate park historian, $3,200 to $3,800, and assistant park historian, $2,600 to $3,200, must also be received not later than March 25. The examinations are to fill vacancies occurring in the National Park Service. There are present vacancies at the Colonial National Monument, Yorktown, Virginia. The duties are to carry on historical, educational and museum work in the fields of history. In the case of all these examinations competitors will not be required to report for examination at any place, but will be rated on their education and experience, and on a thesis or published writing.

Plans have been announced for the annual trip of the Harvard Summer School of Geology. The locality which will be studied in detail will be the north central part of New Mexico, in the Nacimiento and Jemez Mountains. Instruction will be conducted by Professor Kirk Bryan, who has made a geological study of this area. Six days a week will be devoted to mapping and to studies of land-forms in this part of the country. The second part of the summer will be spent in a rapid reconnaissance, covering 1,500 miles in New Mexico, Colorado and the north of Texas. The traveling will be done by truck, and the party will usually camp out. The first place that will be visited is the northern basin of the Rio Grande, where ancient lakes will be studied. From there the party will go to the salt lakes in the enclosed basin of the Estancia, and across the plains of eastern New Mexico, ending at the Carlsbad Caverns. The trip will cost $175, meals included, starting at Albuquerque, and it will count as a half course in the university. Enrolment is limited to those who have completed at least a full year of study in geology.

According to a report in the *Journal* of the American Medical Association, obtained from the American representative of the Soviet Red Cross Societies, medical education in the Union of Socialist Soviet Republics, which was reorganized in 1930, now has three divisions, or faculties. These are (1) the curative-prophylactic faculty, which is divided into surgical, therapeutic and stomatologic departments; (2) the sanitary-prophylactic faculty, which is divided into epidemiologic, communal housing, nourishment and sanitary-industrial departments, and (3) the faculty for the protection of motherhood and childhood, which has two departments, one for mothers and infants, the other for children and adolescents. Except in the second division and the stomatologic department of the first, medical instruction covers four years. After a year's internship, graduates of the curative-prophylactic faculty and of the faculty for the protection of motherhood and childhood have the right to practice medicine independently. Physicians who have received their medical training outside of Russia may practice only after they have completed one year of practical medical work in institutions controlled by the commissariat of health. Applicants must also pass examinations on the principles of Soviet health protection.

The National Tuberculosis Association announces a limited number of fellowships in social research as related to tuberculosis, open to graduate students who have had special training in statistics, social science or public health. Preference will be given to candidates who are interested in pursuing research in public health after the completion of this fellowship. Researches on topics selected by the National Tuberculosis Association will be conducted in collaboration with colleges and universities, and each study will be under qualified academic leadership. Academic credit

may be allowed for this research according to arrangement with the individual universities under whose supervision they are undertaken. Each fellow will be required to submit a written report at the completion of his fellowship grant and the text of that report shall remain the property of the National Tuberculosis Association. Candidates will be considered not alone on academic standing, but on experience and general fitness for research work. The fellowship grants will date from the beginning of the academic year in the fall of 1931. They are for a twelvemonth period and the fellowship grant amounts to $1,500 for that period with a month's leave for vacation. Interested candidates should write to Jessamine S. Whitney, Statistician, National Tuberculosis Association, 370 Seventh Avenue, New York City, for further information.

ACCORDING to the London *Times* an advisory Standing Commission on the British National Museums and Galleries is in process of formation. It is understood that the following have been invited to serve upon the commission: The Earl of Harewood, Lord Hanworth, Mr. C. R. Peers, Sir Richard Glazebrook and Sir Henry Miers. The creation of such a standing commission, which should review each year the draft estimates of the National Museums and Galleries, and advise generally upon the position, was among the recommendations of the Royal Commission on National Museums and Galleries. While such a body is intended principally to act as mediator between the various institutions and the treasury with a view to discouraging extravagance and assessing rival claims, it was suggested by the Royal Commission that it could also promote coordination between the national and provincial museums, and incidentally stimulate private benefactions. The function of the commission will, it is understood, be purely advisory, and it will not have executive control, apart from any influence exercised through the treasury or other government offices, over the trustees and similar bodies which at present govern the various institutions.

DISCUSSION

DEPOSITION OF SEDIMENT IN LAKES BY GLACIAL STREAMS

ON June 13, 1930, the writer had the opportunity to observe, from the deck of a steamer, the discharge of the Rhone River into Lake Geneva. At this time there was rapid melting of snow from the mountains and of the ice of the Rhone Glacier (seen about a week later) and the river was a yellow flood of cold water. From thermometric observations made on similar streams in Alaska, in 1909, it may be inferred that these snow and glacially derived waters of the Rhone had a temperature only a few degrees Fahrenheit above the freezing point, that is, they were within the temperature range where fresh water is most dense. The surface waters of the lake, on the other hand, were sufficiently warm to attract a few bathers to a beach at the head of the lake, a mile or two distant from the Rhone outlet.

Immediately on coming in contact with the lake waters, at what was evidently the edge of the steep, fore-set slope of the delta, the river waters sank beneath the surface. The demarcation between the blue waters of the lake and the yellow waters of the river flood was of line-sharpness; no zone or belt of turbidity could be seen, nor was there any turbidity of the surface waters of the lake at distances farther out in the lake. At the line of disappearance the yellow river waters had still a strong current, to the degree of being rippled on the surface; a current probably competent to transport coarse sand in suspension. The line of separation between the lake and river waters made the pattern of a delta with the base, in the lake, generally straight, and several times longer than the stream width at the apex of the triangle. In detail this base-line front of the delta had a crenate outline; a pattern that served to round off the angles between the base and the other two sides of the triangle.

From these observations it would appear that where the waters of a glacial stream, at temperatures where water is of maximum density, empty into a body of fresh water with relatively warm surface layers, sinking of the cold waters, together with their sediment load, is abrupt and complete at the outer edge of the top-set beds. Accordingly, if the water of the lake is of adequate depth in relation to the developed thickness of the delta deposit the fore-set beds should be of the maximum steepness permitted by the angle of rest under water of the material deposited. Further, their composition and cross bedding should be comparably heterogeneous to that of the top-set beds.

These deductions are fulfilled in a marked degree by the form and composition of the hanging deltas built into proglacial lakes at various levels, as found in the Finger Lakes district of central New York. The higher levels of such deltas quite invariably have very steep fronts, forty and more feet high, with straight rather than curved or serrate outlines. Where such delta terraces have been cut through in building operations or for use as a source of sand and gravel they show little difference in composition or coarseness of materials between the top-set and fore-set beds.

While there is such correspondence between the

form of the deltas deposited in the proglacial lakes and the process observed at the Rhone River-Lake Geneva junction, it is probable that the deposition of the deltas in the proglacial lakes was only exceptionally done under the extreme conditions of temperature difference present at the Rhone River-Lake Geneva site. It may be presumed that the surface waters of the proglacial lakes were ordinarily colder and that the stream waters were warmer and chiefly derived from precipitation on land. However when the higher level terraces of these delta deposits were made the streams were in part, at least, fed by ice melting.

On June 15, 1930, the conditions and phenomena noted at the Rhone mouth in Lake Geneva were also observed where the Lutschinen stream from the Lauterbrunnen valley empties into the Lake of Brienz at Interlaken. At this site the lake waters at the delta front were very shallow and the sediment load was so great that the advance of the front of the delta might be said to be quite entirely brought about by top-set beds. That is, there was the same abrupt checking of the current of the stream as with the Rhone but the Lutschinen was visibly transporting coarse gravel to the line of disappearance of the glacial flood.

In contrast with these conditions are those present at the mouth of the Cayuga Inlet stream that enters the south end of Cayuga Lake, New York. There the stream waters are, during spring and early summer, commonly warmer than the lake waters, especially in periods following a prevailing south wind. Consequently it is a conspicuous phenomena that the lake waters during flood flows of the Inlet stream are discolored for a half mile or more out from the mouth of the stream. The lake waters over this section are very shallow, the bottom having a very gentle slope. In this instance the colder lake waters appear to exert a significant effect in buoying up the finer sediment and giving it a wide-spread deposition.

In addition to their bearing on the interpretation of delta forms and deposits generally these observations may have some significance in relation to the conditions under which deposition of varved clays in glacial lakes comes about.

O. D. VON ENGELN

DEPARTMENT OF GEOLOGY,
CORNELL UNIVERSITY

SUFFOCATION POINT IN THE HORNED LIZARD, PHRYNOSOMA CORNUTUM

THE horned "toad" or horned "frog," as this lizard is commonly called, has won a great deal of publicity in recent years concerning its ability to withstand suffocation and starvation for long periods of time. The following article will serve to supply some definite information on its hardiness and lethal point in respect to suffocation. Two series of a number of different individuals each were used, and the results seem fairly consistent. One series was run in respiratory chambers where the carbon dioxide discharged by the animal was allowed to remain and accumulate, while in the other series, soda lime was used to absorb the carbon dioxide as it was produced.

The animals were placed in stoppered bottles, properly arranged to serve as respiratory chambers. The size of these chambers was between 900 and 1,000 cc in volume. When the animal had been kept in the respiratory chamber for the desired length of time at a known temperature and in a known volume of air, a sample of about 9.5 cc of the air was drawn from the outlet of the chamber directly into a portable Haldane gas analysis apparatus and analyzed for carbon dioxide and oxygen. The weight of the animal was also noted in each case. The samples were taken either immediately after the animal was dead or after it was in great distress, shown by labored gasping and struggling, which indicated that it would very soon die if allowed to remain in the chamber.

According to the results of these experiments, the animals which were actually carried through until death in the chambers where the carbon dioxide was allowed to accumulate consumed the oxygen down to a point where the air in the chamber contained between 4 and 5½ per cent. oxygen. Normal air contains about 20.93 per cent. oxygen. Carbon dioxide was produced in these chambers until it reached percentages ranging from 12 to 15 in different individuals at death, while normal air contains only approximately .03 per cent. The other animals included in the series, which were at their limit and would have died very soon, show an oxygen and carbon dioxide range that is very similar to the range for the ones which were killed.

The second series of experiments, where the carbon dioxide was absorbed, show the animals reaching the lethal point of suffocation only after the oxygen content of the respiratory chamber has gone down to 3.21 per cent. on the average. One or two individuals in the first series were able to survive until the oxygen content went down to about 4 per cent., but this was not the rule. It is seen immediately that the carbon dioxide effect is quite marked here.

The larger animals of course consume more oxygen and can survive a much shorter time than a smaller animal in a chamber of similar size. As would be expected, the temperature affects the rate of respiration quite sharply in this lizard, especially during the summer, and of course enters prominently into the

length of the survival time in a limited volume of air. These animals do not struggle or move about to any extent so that the metabolic factor did not influence the survival time to any great degree in these experiments.

At temperatures of 23° to 26° C., specimens of the average weight of those used above will survive in a liter bottle for ten days or more before the point of suffocation is reached. At 35° C. the point of suffocation is reached in two or three days in bottles of similar size. When the temperature is down to about 10° C. with the animals in hibernation, it has been found that those of the average size, as considered above, will live for about two months in a liter chamber of air.

These experiments, which are only a part of more extensive ones, give a rather definite idea of the lethal point for suffocation in oxygen percentages and carbon dioxide percentages for this animal, as well as reviewing the factors influencing the survival time. This is a preliminary report.

GEORGE E. POTTER

BAYLOR UNIVERSITY

GRADUAL OBLITERATION OF THE PORTAL VEIN AS A SUBSTITUTE FOR ECK-FISTULA[1]

THE diversion of the portal blood directly into the vena cava was accomplished by N. V. Eck[2] in 1877 by means of the fistula which bears his name. This procedure has been exceedingly useful in the study of many problems concerned with the physiology of the liver and organs whose venous blood drains into the portal system. Its application has been somewhat limited by the technical difficulties of the operation, particularly for those not trained in blood vessel surgery. During the past three years the author and associates, J. C. Ellis and W. B. Mathews, have made use of a more simple method for accomplishing the same purpose. It consists essentially in producing so gradual an obstruction to the portal vein that the collateral anastomoses in the esophagus and rectum develop sufficiently to prevent gangrene of the intestines. This may be accomplished by means of a two-stage operation in the dog, cat, goat, rabbit and rat. At the first operation, the portal vein is carefully isolated and two strong linen threads introduced around it above the entrance of the pancreatic-duodenal branch. One of these threads is then tied sufficiently to produce a constriction of the portal vein to about one half of its normal diameter. A slight congestion of the intestines may occur which rapidly disappears. The ends of the second thread are then fastened to the abdominal wall so they may be readily found at the second operation. The second operation may be done two to three weeks later, at which time the portal vein is completely occluded. Gangrene of the intestines does not occur. The operation is very simple and there is practically no mortality. A demonstration was made of this method at the meeting of the American Physiological Society in Chicago in April, 1930. It is altogether probable that many others have used this or a similar method before. I have been prompted to publish this note because of the many requests received during the past year for details of the method. We have used it successfully on the various laboratory animals listed above.

LESTER R. DRAGSTEDT

[1] From the Department of Surgery of the University of Chicago.

[2] N. V. Eck, *Militar-medicinisches Journal*, 1877, cxxx, Jahrgang 55. Travaux de la Soc. des Naturalists de St. Petersburg, 1879, x. 55.

DEVIL'S SHOE-STRING AS AN INSECTICIDE[1]

THE investigator's attention was attracted to the possibilities of devil's shoe-string, *Cracca virginiana* Linn., as an insecticide three years ago through studies of derris, and particularly through the physiological action of derris on fish. The roots of both plants are powerful fish-poisons and, from all accounts, affect fish in a similar way. No references in literature have been found where this species has ever been used for insecticidal purposes; however, studies have been made by several investigators of foreign species of this genus. The most important studies were made by F. Tattersfield, C. T. Gimingham and H. M. Morris.[2]

Roots were dug from several localities at various times of the year and were dried by different methods. They were then finely ground in an herb mill. Careful and repeated experiments with aqueous suspensions were made under laboratory conditions on the cotton or melon aphis, *Aphis gossypii*. Marked variations in toxicity were found, due to the season, soil, method of drying and probably various other factors. The most toxic samples were obtained from sandy soil, dug in the hottest part of the year and dried in the sun. Drying in the shade, boiling in water and heating the roots caused a loss in toxicity. Comparative data with nicotine sulphate (40 per cent.), and aqueous suspensions of derris and a commercial brand of pyrethrum showed that the best samples of devil's shoe-string were slightly more toxic than pyrethrum, but were less toxic than derris; however, they compared more favorably with derris than derris with nicotine sulphate (40 per cent.).

[1] Contribution No. 24, Department of Entomology, Texas A. and M. College, College Station, Texas.

[2] "Studies on Contact Insecticides," Parts 1 and 2, Vol. 12, and Part 4, Vol. 13, Annals of Applied Biology.

Observations showed that devil's shoe-string kills in a manner similar to that of derris. Its action is as quick or even more so, but it takes a somewhat longer time for the insects to die. It kills through paralysis and perhaps also through interference with respiration.

Field experiments on plant lice, *Aphis gossypii* and *Rhophalosiphon pseudobrassicae,* tent caterpillars, *Malacosoma americana,* yellow-necked caterpillars, *Datana ministra,* and Colorado potato beetle larvae, *Leptinotarsa decemlineata,* showed that the plant has considerable promise as a contact spray. But it possibly has greater promise for the control of various animal parasites. Almost perfect results were obtained on various species of fleas and lice; and encouraging results were obtained on cattle grubs, *Hypoderma lineatum.*

The supply at present is probably adequate for commercial purposes; but due to marked variations in the toxicity of the plant, it may not be possible to wholly utilize the available supply. Its commercial possibilities probably depend upon how cheaply it can be grown and harvested. A more detailed article will soon appear elsewhere.

V. A. Little

Agricultural and Mechanical College of Texas

BIOCHEMISTRY IN RELATION TO INTELLIGENCE

Many people seem willing to believe that the chemicals in one's body may affect one's mind; but, apparently, scientific literature has been extremely vague or altogether silent on the subject, except in the case of glandular secretions, certain drugs and the like.

In an attempt to determine whether there is a characteristic chemical difference between "intelligent" persons and idiots, blood tests were made on 12 normal or superior persons and 20 idiots. All the subjects were adults of approximately the same age and health, and in each group there was an equal number of males and females. Differences in diet were made note of, and the time of day at which blood was taken and the interval elapsing before the tests were kept fairly constant.

The Clark-Collip modification of the Kramer-Tisdall method was used for the determination of calcium, with the result that practically every case came within the normal range; all the idiots were normal in their calcium-content.

The Fiske-Subbarrow method was used for the determination of inorganic phosphate in blood plasma. The phosphate-content of the normal group was found to range between 3.25 and 8 mg per 100 cc of blood, but in only one case was it above 5.88 mg and in that case a retest one month later showed 3.01 instead of 8 mg, suggesting that the excess was temporary. Without a single exception, the idiots had a high phosphate content, ranging from 5.98 to 12.48 mg and averaging 8.95 mg per 100 cc of blood, as compared with an average of 4.36 mg for the normal group.

No characteristic sex differences appeared in calcium or phosphorus, and there was no reciprocal relation between the amount of calcium and that of phosphorus, especially in the case of the idiots.

Several other experiments on this general subject are in progress.

H. D. Powers

Willard, North Carolina

THE LANGUAGE OF A CLERGYMAN

It was gratifying to find that my modest paper on "The Language of Scientists," printed in Science for December 5, 1930, excited some interest. I had very appreciative and helpful letters from various parts of the country and from men engaged in many different scientific specialties, showing that the points treated of were considered important and timely.

And now I have the valuable criticisms of two correspondents in Science for January 16, 1931. I enjoyed reading these as much as I suppose the writers enjoyed making their very appropriate comments.

It was hardly fair, however, to visit the errors of this one poor sinner on the whole class of clergymen. To be sure I know many of them who say "dioscize" for "dioceses," who make three syllables of "Reredos" and who even will put the accent on the penult of "deficit," but as a class I am not aware that they are particularly weak on rhetoric, as I seem to be. At any rate this clergyman will try to be more careful in future and to get some keen-nosed rhetorician to revise anything he may prepare for publication.

There is only one word to which I take exception. Dr. Theodore W. Darnell, of New York (I do not know him, but I am sure he must be a Litt.D.), speaks of my "castigation" of my fellow members. Now this was just what I had no intention of administering. I wrote in a humble and sympathetic spirit and hoped that none would feel that I was being censorious in the ordinary meaning of the word. In fact one of my correspondents voluntarily congratulated me on my success in this particular. But the effect of the written word depends, not only on the disposition of the writer, but also on that of the reader. This latter it is impossible to guard against entirely. To point out errors is neither a pleasant task nor likely to excite gratitude in one who feels that he is himself perhaps guilty of some of them. I did not spare myself and told of my own mistakes and said that *we* were all *liable* to err instead of charging, "*You* are all *likely* to err."

And really I am a little disappointed in Dr. Darnell. After all my efforts to point out the undesirability of using mongrel words, he asks whether "supercritical" or "hypercritical" is correct, and seems to imply a preference for the Latin-Greek hybrid rather than for the nice, pure Greek compound.

GEORGE W. LAY

CHAPEL HILL, NORTH CAROLINA

SCIENTIFIC BOOKS

The Stars of High Luminosity. Harvard Observatory Monograph No. 3. By CECILIA H. PAYNE. New York and London, McGraw-Hill Book Company, Inc., 1930, 8-vo. pp. ix, 320. Price $3.50.

IN 1925, Miss Payne published her first book on "Stellar Atmospheres" as No. 1 of the series of Harvard Monographs. The volume had a notable success. Not only astronomers, but also physicists and physical chemists found in it a much-needed summary of the maze of observational data which had accumulated since the discovery of the spectroscope. The theory of ionization was then less than five years old, and it was particularly appropriate to discuss the data from the point of view of the new theory. Since that time more than five years have passed. The theory has been greatly extended, the technique of measuring the intensities of spectral lines has been improved and adapted to the requirements of the theory, and a great amount of observational material has been accumulated. Since "Stellar Atmospheres" is now out of print and many parts of it out of date, Miss Payne has written an entirely new book which is to supersede and to complete her earlier volume.

The title of the new book is somewhat misleading. It covers a far wider ground than its narrow, perhaps even slightly artificial name, "The Stars of High Luminosity," might indicate, It is in fact a "physical study of stars by means of their spectra," as the first sentence of the book states, and it covers the subject of "Stellar Atmospheres" no less completely than did her first work.

The new book covers an epoch in observational astrophysics. It is one of those rare books that treat a whole field of knowledge from the purely scientific point of view and do not attempt the impossible in catering to the professional astronomer and to the layman at the same time. In a volume of 320 pages, neatly printed on excellent paper, Miss Payne has given a summary of her work and her ideas on the subject of the physical interpretation of stellar spectra. In a clear and vivid style she has given an account of the ionization theory and of various related subjects, primarily from the observational point of view. Being purely "scientific," a layman will get little out of it, but it will be highly appreciated by the scientific world. Astronomers, and perhaps even to a greater degree physicists and chemists, will find here a collection and a critical analysis of the many important facts that observations of stellar spectra have revealed.

The point of view which the author adopts in her new book is distinctly less objective than the one used in "Stellar Atmospheres." Apparently her intention has been more to give an account of her individual research rather than a balanced summary of all knowledge on the subject. As she states in the introduction: "It (the book) carries the work as far as I believe it can be carried with the kind of material available to me—spectra of comparatively short dispersion, either unstandardized or standardized by simple and unrefined methods."

The book falls naturally into four major parts. In the first the author discusses briefly the methods employed in modern spectro-photometric investigations, and the theoretical foundations of the work.

It has been known for some time that stellar absorption lines are not infinitely narrow, nor do they cut out all of the light from the continuous spectrum. Careful analysis has revealed that some lines are wide, while others are narrow; in some the amount of radiation that is cut out from the continuous spectrum is great, while in others it is small. The first task of the investigator is to measure the contours of the absorption lines and to attempt to obtain from these measurements information concerning the physical character of the outer atmospheres of the stars. Physical theory has been helpful in this respect. Through the work of Unsöld and of Stewart, to name only two of the whole succession of brilliant physicists who have worked on this problem, we have definite information as to the manner in which an atom absorbs when it is struck by a quantum of light: it appears that certain very definite laws concerning this absorption can be formulated, and from them important conclusions can be drawn with respect to what is called "the number of active atoms in the atmosphere of a star." In reality this number refers to *all* the atoms above a certain level in the atmosphere, and E. A. Milne has shown how this level can be determined. Miss Payne adopts the method of expressing her measurements in numbers of atoms, and all of the results contained in the book are more or less closely related to this procedure.

The second part of the book is entitled "The Material." This does not refer to the spectroscopic data

resulting from her measurements, for these form the essence of the following part, "Results of Observation." She discusses the character of the stars which she has investigated, and defines the meaning of the term "stars of high luminosity." There is some uncertainty in the distinction between stars of high luminosity and stars of low luminosity, but a line must be drawn somewhere and Miss Payne places it at absolute magnitude -2.0. The book is primarily concerned with stars which are brighter than this value, but since her method involves a comparison of luminous stars with normal stars, she has included in her discussion virtually all types of stellar spectra.

The nucleus of the book is Part III entitled "Results of Observation" and covering a total of 190 pages. The various spectral types are taken up one by one, and the spectral differences between normal stars and high-luminosity stars are discussed for the more conspicuous spectroscopic features. The inclusion of a separate chapter on "The Variable Star" seems especially appropriate. This chapter more than any of the others illustrates how much remains to be done on the subject of high-luminosity stars. There are many correlations and an even greater accumulation of observational data. But no clear understanding of the nature of a "variable star" is as yet available.

In the chapters that deal with the earlier spectral types one is struck by the change in the temperature scale for the hottest stars, compared with the one adopted by Miss Payne five years ago. It has usually been believed that early B-type stars have a temperature in their reversing layers of the order of 20000 °C. Miss Payne now adopts the very much lower value of 13200°. The reason is obvious. The theory of ionization, as used in the method of maxima of Fowler and Milne, does not directly yield the temperature. It can and does establish a certain relationship between pressure and temperature, but one of these two factors must be known beforehand, *only in that case* can the other be evaluated. The work of Fowler and Milne has pointed this out very clearly. It was only a reasonable guess, an assumption, on their part that the pressures in all reversing layers, irrespective of spectral type, were of the order of 10^{-4} atm. Assuming this to be true the old temperature scale was derived. But there is no reason to believe that the pressure must be the same in all types of stars. In the later types, approaching the sun, we depend upon the energy-distribution of the continuous spectrum to give us the temperature. The pressure is then derived from the ionization formula. In order to be consistent we should adopt in earlier spectral classes, too, the temperatures as given by the energy-distribution, and then determine the pressure. The result is surprising. The energy-distribution points unmistakably to very low temperatures for many of the stars of earliest spectral types, and the resulting pressures are of the order of 10^{-13} atm. There is a large amount of evidence against such low pressure and Miss Payne very correctly rejects this interpretation. We are left with the disquieting necessity of doubting the evidence of the continuous spectra: the distribution of the energy as a function of wave-length does not give us the true temperatures of the stars. But what is then left of our temperature scale? On the one side we are not willing to adopt equal pressures for all spectral types; on the other we find that what we thought was the only trustworthy method of deriving stellar temperatures is giving us erroneous results. The first problem is, of course, to investigate the causes which make the method fail. Is it due to a real failure of the light of the stars to conform to the radiation law of black bodies, or is the light of the stars changed in passing through interstellar space? Miss Payne adopts the first alternative and dismisses the second rather briefly. But her reasons for doing so are perhaps not binding. She suggests that there is a departure from black-body radiation which makes itself manifest in the form of a violet depression in the more luminous B-type stars. If the color temperature is determined from the range of wave-lengths affected by the depression, we should obtain low temperatures. On the other hand, were we to go further into the ultra-violet, we should gradually come back to the true temperature distribution, and no anomaly would be observed. This idea the author supports by the statement that the photoelectrically determined color-indices by Bottlinger show less reddening effect than direct spectro-photometric measurements made at Harvard for the same stars. She suggests that this is due to the difference in color-sensitivity of the two methods: the sensitive point of Bottlinger's measurements being to the violet of that of the Harvard measures. But is this really so? Bottlinger used a potassium cell with a violet filter having maximum sensitivity at λ 3650. The whole instrument was attached to a refracting telescope. Surely the maximum sensitivity of the combination could not have been much to the violet of λ 4000, and indeed, Bottlinger himself suggests that the radiation to the violet of this point was without effect upon his measurements.[1] Compare this with the recent spectro-photometric results of Trumpler (not available when Miss Payne's book was written). Here a quartz spectrograph was used attached to a reflector. The microphotometer curves extend to about λ 3400, and no evidence of any depression is visible. But the effect of reddening is very pronounced.

[1] Sensitivity curves for Bottlinger's measurements are given in Handbuch der Astrophysik 2, 861, 1929. The maxima are at λ 4300 and λ 4700.

The crucial test would, of course, consist in the determination of color-temperatures of groups of stars in open clusters, where all the members are known to be at the same distance. If the hypothesis of Miss Payne is correct, the more luminous stars should show more pronounced reddening than the less luminous stars of the same spectral types. If Trumpler is right, the amount of reddening should be the same for all stars. Miss Payne mentions in this connection the work of Balanovsky and states that there is some evidence in his results favoring her point of view, but she states that "quantitative estimates of the temperature can not be made from his discussion."

Incidentally it may be noted that there is a correlation between reddening of B-type stars and intensity of the interstellar calcium lines, and, contrary to the statement of Miss Payne's book on page 120, there is a very pronounced concentration of red B-type stars in the very region where some of the strongest interstellar lines are observed (in the constellation Cepheus and in adjoining regions). But this does not mean that the reddening may be caused by the calcium itself: the amount of matter, in the form of ionized calcium, in the line of sight between the observer and some of the most distant stars is not more than is contained in one cubic centimeter of air at normal pressure and temperature. It is clear that so small an amount of matter could never produce the enormous amount of reddening observed by Trumpler and by others.

Whatever the outcome of this extremely interesting problem may be, we are left with the unsatisfactory state of our present temperature scale. Future work will have to deal with this side of astrophysics, and will have to devise new methods by which this scale may be ascertained. If the reddening should turn out to be due to interstellar absorption, then there would be no reason to question the radiation laws. The nearer stars would give us more nearly correct temperatures than the more distant stars, and an extrapolation should enable us to get the energy-distribution for zero distance. If, however, space reddening is not present, the matter would be more complicated. Perhaps the study of the Stark effect in stellar spectra may help to establish another function of temperature and pressure. It should then be possible from this and from the ionization formula to evaluate pressure and temperature independently. Even now it is possible to say, from the Stark effect alone, that pressures of the order of 10^{-13} atm. are not possible, and that consequently the energy-distributions can not be taken at their face value. An independent determination of the temperature scale could perhaps be obtained by a method similar to the one used by Adams and Russell in 1928.

Speaking of the ionic Stark effect, it is of interest to note that Miss Payne finds evidence of its existence, at least in spectral class A. The question might justly be asked: if ionic Stark effect is present, is it permissible to apply the Unsöld formula to the evaluation of the numbers of atoms? Strictly speaking the absorption coefficient in a line affected by Stark effect is not that given by the classical theory (as was pointed out by Unsöld) and the formulae which may be used for lines produced by radiation damping are not applicable. But it is fairly safe to say that the discrepancy will not be a serious one and that the numbers obtained will at least be comparable to those that would apply in the case of no Stark effect.

The last part, "Analysis of Stellar Atmospheres," gives a short summary of the observational results described in the preceding chapters and discusses them, rather briefly, in the light of the "generalized" ionization equations of Milne.

There are many useful tables in the book. A complete list of O stars, a catalogue of stars showing the so-called c-characteristic in their spectra, and a list of Cepheid variables add greatly to the value of the volume.

O. STRUVE

YERKES OBSERVATORY,
WILLIAMS BAY, WISCONSIN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NOTE ON CAPSULE STAINING

SOME difficulty in securing good results is frequently encountered in the routine laboratory exercise on staining capsules by the well-known method of Hiss.[1] In an effort to make this procedure more adaptable to class use several variations have been tried and a series of dyes compared by various procedures. The dyes tested were as follows: crystal violet, 84 per cent., crystal violet, 92 per cent., crystal violet (dye content not stated), methyl green, gentian violet, methyl violet 1 B, methyl violet 2 B (two brands) and aniline violet. The organisms were pneumococcus from the peritoneal cavity of an infected mouse and Klebsiella pneumoniae from serum agar slants. Thin smears were made without the use of a diluent; the films were allowed to dry in the air and stained without fixation.

Methyl green was not found to be a satisfactory stain by any of the procedures tested. More or less

[1] P. H. Hiss, Jr., "A Contribution to the Physiological Differentiation of Pneumococcus and Streptococcus, and to Methods of Staining Capsules," *Jour. Exper. Med.*, 6, 317, 1905.

satisfactory preparations could be obtained with most of the other stains, but the best results were from the use of a 1 per cent. aqueous solution of crystal violet, 84 per cent. dye content. The staining was carried out in the cold for two minutes. The slide was then washed with 20 per cent. copper sulfate in the usual way and blotted dry. Better differentiation was obtained by this procedure than by any other method tested. An increase of the staining time did not improve the results obtained.

The procedure given above has been tried out in class with practically no failures, a condition which rarely prevailed with the original method of Hiss.

In view of the fact that the method here given does not require steaming in order to secure satisfactory results in a short period of time, it is felt that it is to some extent an improvement over the earlier method. An added advantage is to be found in the fact that the staining solution is the same as the primary stain of the Kopeloff and Beerman modification of the Gram stain, this being one of the methods recommended in the "Manual of Methods" of the Society of American Bacteriologists.[2]

E. E. ANTHONY, JR.
DEPARTMENT OF BACTERIOLOGY,
UNIVERSITY OF TEXAS

PREPARATION OF BEE SLIDES

THE following combination of methods has been found very satisfactory for clearing and mounting the chitinous skeletons of insects. It is particularly adaptable to the preparation of the head and mouth parts, the legs, or total mounts of bees, when they are to be used for the gross study of the skeletal structures.

When preparing mounts of each of the three types of legs and the head, the desired number of each are removed and each group tied up in small cheesecloth bags so that they may be handled more easily during the first part of the process.

The bags are placed in a small porcelain dish and covered with a solution of 20 per cent. potassium hydroxide, and boiled for 15 to 30 minutes.[1] As the water evaporates more of the solution is added so that the concentration is increased during the boiling. Remove the bags and wash in running water for 12 hours. Pressing the bags gently and then releasing them several times at two or three hour intervals assists greatly in thoroughly washing out the cavities in the skeletons.

When washed, the parts are bleached to the shade best suited for study. For bleaching Mayer's Chlorine Method[2] is used. For the bee preparations the following proportions were found to give best results: Concentrated HCl 3 cc, 70 per cent. alcohol 10 cc. This is put in a small vial and to it is added potassium chlorate, a few crystals at a time. The parts to be bleached are put in the solution and left until the desired shade is obtained. More of the potassium chlorate is added each time the liberation of chlorine ceases. The parts can be bleached to a creamy white and stained, but it has been found quite as satisfactory to bleach until the color is a light tan, no staining being necessary. It is advisable to remove the parts from the bags and treat a few at a time so that the amount of bleaching can be regulated.

When the parts are removed from the bleach they must be handled with care until after hardening. Wash in four or five changes of distilled water for 30 minutes. The heads are now placed on a slide in a drop of water and the mouth parts arranged under a lens. A second slide is placed on top and the two pressed together to flatten the head. See that the mouth parts are not disarranged, and then put a rubber band or clip around both slides and place in 80 per cent. alcohol for one hour. Drain and put in 95 per cent. for one hour. The parts are now hardened in position and can be removed from the slides and placed in absolute alcohol. The other parts which do not need flattening are carried through the same procedure all together. Use two changes of absolute, one hour and two hours, then clear in clove oil for 24 hours. Mount in balsam.

Total bees can be fixed in the same manner and suitably arranged before hardening. By careful pressing the total bee or bee's head can be flattened so that it is no thicker than a No. 1 cover-glass.

L. S. ROWELL
UNIVERSITY OF VERMONT

CHEMICAL TREATMENTS TO SHORTEN THE REST PERIOD OF TREE SEEDS

IN the past three years it has been demonstrated that the dormant seeds of sugar maple, Norway maple and the acorns of black oak and red oak can be stimulated into germination by treatments with solutions of thiourea and ethylene chlorhydrin and by the vapors of ethylene chlorhydrin. While full details of these investigations will be published later it is thought desirable to make available the methods which have given the best results to date.

With sugar maple and Norway maple seeds, immersion of the seeds in a 3 per cent. solution of thiourea for 1 minute proved to be the most successful treatment. The solution was drained off the seeds and the bottle stoppered and the seeds allowed to

[2] "Manual of Methods for Pure Culture Study of Bacteria," Society of American Bacteriologists, Geneva, 1928.

[1] KOH for softening. Kingsbury and Johannsen, "Histological Technique," p. 130, par. 318. Lee, "Vade Mecum," 7th ed. par. 551.

[2] Mayer, "Chlorine Method." McClung, "Microscopical Technique," p. 478, and Guyer, 1st ed. p. 45.

stand for a day before planting. Immersing the seeds in 3 and 6 per cent. solutions of ethylene chlorhydrin (made by mixing 6 and 12 milliliters, respectively, of ethylene chlorhydrin, technical, with 194 and 188 milliliters of water) also was effective. The seeds were immersed for a minute, the solution poured off of them and the bottle stoppered for twenty-four hours before planting.

With black and red oak acorns consistently good results have been obtained by subjecting 50 or 100 acorns in a liter wide-mouth bottle to the vapors of four milliliters of ethylene chlorhydrin, technical, for twenty-four hours. The chemical was placed on a five-inch square of cheesecloth suspended from the stopper. This treatment initiated germination of acorns gathered in October within four weeks and within ten weeks more than 70 per cent. had germinated while the acorns not treated showed 1 per cent. or no germination. Immersion of these acorns in a 3 per cent. solution of thiourea for 15 minutes was effective but slower than the ethylene chlorhydrin vapor treatment. Germination in acorns treated with thiourea solution did not start until the seventh to tenth week after treatment.

It is not claimed that the procedures described are the best methods of hastening dormant tree seeds into germination with chemicals since much more work needs to be done upon the most effective concentrations of the chemicals and the most effective time periods of treatment but these chemicals do give a new mode of attack upon dormancy in seeds. The results reported are based on tests made with more than 9,000 maple seeds and 5,000 acorns.

CARL G. DEUBER

OSBORN BOTANICAL LABORATORY,
YALE UNIVERSITY

SPECIAL ARTICLES

THE BIOLOGICAL EFFECT OF HIGH VOLTAGE X-RAYS

FOR many years radiologists have debated the question whether equal doses of X-rays of different wave-lengths produce the same or different quantitative biological effects, a problem of practical importance in therapy. The chief obstacles in deciding the matter were the lack of a standard unit of X-ray intensity, the lack of adequate measuring apparatus and the highly variable character of the biological materials which were used in making the tests. The adoption of a standard unit, the Roentgen, now permits an accurate definition of dosage, where previously none was possible. The question now is this: When a definite number of r units, measured by an air ionization chamber, is delivered to a suitable material, will the amount of effect which is produced vary with the wave-length of the beam, that is, with the voltage.

An almost ideal biological material consists of the eggs of the wild fruit fly, Drosophila. These eggs when freshly laid are comparatively sensitive, and are remarkably uniform in response. Different strains of wild flies are apparently equally radiosensitive. Therefore one may make experiments with them anywhere with the assurance that his results will be comparable with those obtained by other workers at other places.

A long series of tests[1] with carefully measured beams produced at constant potentials shows that the mortality curve has an asymmetrical sigmoid shape. These tests were made with different wave-lengths, (0.20, 0.50 and 0.70 A. U.), that is, with hard, medium and soft X-rays. In each instance the results showed that the quality of the beam has no effect on the mortality rate; it is the intensity which is the deciding factor. Furthermore, the course of the curve is the same in each case. From such a curve we can determine how many r units are required to kill any percentage of eggs in a sample.

The method may be reversed.[2] By knowing how long a dose is needed to kill, say 50 per cent. of the eggs, we can estimate the intensity with considerable accuracy. Half the eggs are killed by 180 r units. If 10 minutes are required to kill this proportion, the intensity was 18 r/min.

The wave-lengths employed lay within the range of ordinary radiotherapeutic practice, that is, they were produced at potentials of 50 to 180 KV. But now that machines capable of running at much higher voltages are being developed it is necessary to determine whether a definite dose of these very short waves is biologically equivalent to an equal dose of longer waves. We have recently made this test at the California Institute of Technology where a tube which operates at 550 KV is in use.[3]

In these experiments the X-rays were filtered through 6 mm of steel, the emergent beam having an effective wave-length of 0.04 A. U. Ionization tests showed that at the point where the eggs were exposed the intensity was 15 r/min. This includes a small amount of scatter from the walls of the room, amounting to perhaps 1 r/min. The eggs were given 120, 180 and 240 units. From the curve we should expect the percentages of eggs killed to be 22, 50 and 67 per cent. The actual results, which are averages of many tests

[1] Packard, C., *J. Cancer Res.*, 1927, 11, 1.

[2] Packard, C., *J. Cancer Res.*, 1927, 11, 282.

[3] Lauritsen, C. C. and B. Cassen, *Phys. Rev.*, 1930, 36, 988.

involving some thousands of eggs, were 23, 49.5 and 68.5 per cent. Obviously then the fly eggs react to doses of these very short waves in precisely the same way as they do to softer radiation. A further test at 300 KV (0.07 A. U.) demonstrates the same fact.

Another experiment with a different biological material gave similar results. A mouse tumor (Sarcoma 180) was cut into small pieces which were radiated and then inoculated into healthy animals. The criterion of effect was the failure of the radiated pieces to grow. Untreated particles always "take." A number of tests at 550 KV showed that the lethal dose was about 2750 r. This is the same as that found by Wood[4] who used much softer rays (0.20 and 0.70 A. U.).

The conclusion is that between 0.04 and 0.70 A. U. the biological effect of equal doses is the same. How far this equality extends in the direction of still shorter waves, *e.g.*, the gamma rays of radium, and of very long waves produced at a few thousand volts, is still to be determined. Since the effect is produced by secondary radiations generated when the primary radiation is absorbed, it may be expected that there will be an equality through a much wider range of wave-lengths than have thus far been used. Experiments on the action of the Grenz rays whose wave-lengths are from 1.0 to 2.0 A. U. are now in progress.

Because of the great penetrating power of the high voltage rays it is possible to deliver to deep lying tissue a much larger proportion of the incident energy than is possible with less penetrating rays. Theoretically this should be of value in therapy; whether such rays will prove advantageous in practice can be determined only by careful study of the reaction of the patients.

CHARLES PACKARD
INSTITUTE OF CANCER RESEARCH,
COLUMBIA UNIVERSITY, NEW YORK

C. C. LAURITSEN
CALIFORNIA INSTITUTE OF TECHNOLOGY,
PASADENA, CALIFORNIA

THE CORTICO-ADRENAL HORMONE

AN outstanding advance in the physiology of the internal secretions has been made by the development in the past year of potent aqueous extracts of the adrenal cortex. Nearly simultaneous announcements of the maintenance of adrenalectomized animals in perfect health by the administration of cortico-adrenal extracts has been made by Hartman and his collaborators at Buffalo,[1] and by Swingle and Pfiffner at Princeton.[2] The latter observers kept several of their cats alive and in good health over 100 days; Hartman reports that three of his animals lived over 100 days, and one over 200 days. The insignificant effect of cortico-adrenal extracts which have been developed by previous workers has been dealt with at length in a recent review.[3]

In this laboratory we have recently made and tested cortico-adrenal extracts prepared according to the methods of both the Buffalo and the Princeton investigators. The method of Swingle and Pfiffner, although long-drawn-out (taking usually 10 to 14 days) and offering many possibilities for the loss of potency to occur, is simple to carry out; that of Hartman takes only a few days but offers technical difficulties, particularly in the elimination of inert lipoid substances and of adrenalin. On adrenalectomized cats we have tested to date eighteen batches of extract made according to the Swingle-Pfiffner technique, and six batches prepared after Hartman's method.

It can be said positively that the Swingle-Pfiffner extracts contain significant amounts of the cortico-adrenal hormone. On administration of the substance to adrenalectomized cats the life span is at least much prolonged, and may possibly be extended indefinitely. The animals gain in weight and look apparently normal. We have given particular attention, however, to the recovery of animals from the severe symptoms of adrenal insufficiency, and have therefore stopped administration of the extract three or four weeks after adrenal removal, and often earlier. Evidences of resuscitation of adrenalectomized cats from extreme prostration following intraperitoneal injection of the Swingle-Pfiffner extract are apparent in 15 to 30 minutes: convulsions are suppressed, the animals show an interest in their surroundings and attempt to sit up; within an hour or so they may walk about and appear practically normal, and two hours after injection they may take food. Examples of recovery are given from a few of our protocols in Table 1.

We have made up the extract to a final concentration of 30 grams of cortex per cubic centimeter—or 100 cubic centimeters of extract per 4 kilos of fresh ox glands. The injections have chiefly been given intraperitoneally. Usually it has been necessary to inject from 5 to 10 cc of extract per kilo body weight of the animal, in the course of 24 hours, to effect restoration from the pronounced symptoms of adrenal insufficiency. Twenty cc of the extract given intraperitoneally to a small (two-kilo) cat have produced no ill effects. The material is also non-toxic when given subcutaneously, intramuscularly, intravenously or intracardially. In one case injection by the latter route was strikingly effective in resuscitating a coma-

[4] Wood, F. C., *Radiology*, 1925, 5, 199.

[1] F. A. Hartman, K. A. Brownell and W. E. Hartman, *Amer. J. Physiol.*, 95: 670, 1930.

[2] W. W. Swingle and J. J. Pfiffner, *Amer. J. Physiol.*, 96: 153, 1931.

[3] S. W. Britton, *Physiol. Reviews*, 10: 617, 1930.

TABLE I

Date	Cat no.	Condition before extract was given	Results
11/21/30	257	In convulsions	Improved in 30 minutes; walking about in 1 hour; eating 2 hours after injection
12/ 5/30	273	In convulsions	Improved 30 minutes after injection; in splendid condition 6 hours later
12/ 7/30	273	In convulsions	Again rapidly resuscitated following administration of extract
12/10/30	273	Comatose	Sat up 15 minutes following injection; appeared normal 1 hour later
12/11/30	273	In convulsions	Recovery from extreme prostration in 4 hours
1/28/31	276	Comatose	In splendid condition 5 hours after injection
1/30/31	276	In convulsions	Appeared normal within 3 hours; ate salmon

tose animal. We have also used the extract subcutaneously and intramuscularly in man without ill effect.

Our extracts made according to the Swingle-Pfiffner method contain from one-in-one-million to one-in-two-million parts of adrenalin. By control experiments we have shown that the recoveries are not due to adrenalin activity, although we have frequently found the adreno-medullary hormone effective in restoring severely prostrated animals to an apparently normal condition. Much larger amounts of adrenalin than are contained in the cortical extracts must however be given. The restoration with adrenalin is, furthermore, only temporary, lasting usually from 4 to 12 hours. Similarly the recovery from prostration following the injection of glucose solution is very short-lived. We are in definite disagreement with the statement of Swingle and Pfiffner[3] that adrenalectomized animals with severe symptoms show no improvement in their condition and "derive no benefit from the injections" of adrenalin.

It may be noted that the quantity of extract it is necessary to give to prostrate adrenalectomized animals to effect complete restoration represents relatively huge amounts of cortical tissue—a thousand times or more than the amount present in the normal cat. Swingle and Pfiffner, as well as ourselves, frequently gave from 15 to 32 cc of the extract, representing up to nearly 1,000 grams of the adrenal *cortex, in the course of 12 hours, to resuscitate animals* with severe symptoms. And the normal cat possesses only from 200 to 300 milligrams of cortico-adrenal tissue altogether! It seems likely that previous observers may not have secured noteworthy effects with their cortical extracts because of failure to employ the heroic dosage necessary.

Our experience with cortico-adrenal extracts made according to the Hartman technique is somewhat limited, because of the difficulties of preparation mentioned above. The few batches we have prepared we have tested a great number of times on adrenalectomized cats, and in some cases we have obtained indications of the presence of the hormone in the Hartman extracts.[4]

S. W. BRITTON
HERBERT SILVETTE[5]
PHYSIOLOGICAL LABORATORY,
UNIVERSITY OF VIRGINIA,
UNIVERSITY, VIRGINIA

PREMATURE REVERSAL OF HEART-BEAT IN BOMBYX

IT is now well known[1] that in Lepidoptera as in Ascidea there is a regular alternation in the direction of heart-beat, which, in insects, begins in the prepupa and continues during the pupal and adult stages. It is understood, of course, that the direction of heart-beat in most insects is forward, toward the head.

Intermittent backward beating does not normally occur in the full-grown silkworm until it has stopped feeding, evacuated its intestine, spun its cocoon and rested about 24 hours. Then, about 48 hours before pupation, periodic reversal of direction normally begins.

Yokoyama,[2] 1927, has recently stated that this change in type of circulation can be brought on prematurely by closing the posterior pairs of spiracles with enamel paint or by injecting lactic or acetic acid into the 8th abdominal segment. His published graphs apply to the full-grown silkworm during the 5th stage, though he claims to have obtained almost identical results with larvae of the 4th. To induce reversal, according to this observer, 6 pairs of spiracles must be blocked at the beginning of the 5th stage (one day after moulting), one pair less on each successive day, until during the last 5 days (including the period of spinning) only the 3 most posterior pairs (segments 6–8) need be blocked. Similar results

[4] Grateful acknowledgment is made of aid in the above investigations by the Grants-in-aid Committee of the General Education Board.

[5] Porter Fellow in Physiology.

[1] J. H. Gerould, *Jour. Morph. and Physiol.*, 48: 385–429, 1929.

[2] T. Yokoyama, *Dobutsugaku Zachi* [Zool. Mag.], 39, No. 459, Suppl.: 45–51, 1927.

ulated" animal; this giving rise to inequalities in tension within the total organism and resulting in an extrusion of protoplasm at the point of stimulation and a movement in the direction of its source.

Since proteins constitute the essential hydrophilic colloid which makes up the living cell and since we are familiar with a series of chemically well-defined substances which make such proteins swell, the effects of these substances in evoking protoplasmic movement were studied. *Those materials which are known to be hydrators of proteins will, when properly employed, lead to the extrusion of pseudopodia by amoeba and a movement of the organism in the direction of the "stimulus."*

I found that a stock amoeba, grown in an aquarium, would come to rest in approximately spherical form after two washings and a rest period of thirty minutes in a .3 per cent. sodium chloride solution. Transfer was made by means of a capillary pipette in order that as little as possible of the aquarium water might be transferred.

In each of the following experiments a single amoeba was placed in a hollow-ground slide carrying 0.25 cc of the salt solution. The exact position of the amoeba was followed by the insertion of a double-ruled glass disk in the eyepiece of the microscope. This ruling yielded a square, approximately the size of an amoeba, with eight lines radiating from it, each pair of which bounded a lane along which the chemical solutions employed might be introduced and the swelling observed. The solutions were introduced from a capillary pipette fitted with a rubber bulb.

When .005 cc of 5/N HCl is introduced close to an amoeba which has reached a state of inactivity in a sodium chloride solution, the animal responds by sending out a process toward the acid. The whole amoeba may be observed to move toward the acid. After such initial and directional movement and after the acid has had time to diffuse, pseudopodia may be sent out in haphazard fashion over larger areas of the stimulated surface. If, after such treatment, the amoeba is returned to its normal habitat, it moves about normally.

Lactic, acetic and sulphuric acids act similarly when employed in the same amount and strength.

While all acids increase the hydration capacity of protein colloids, they show a large quantitative difference and this difference does not follow their dissociation in aqueous solution or the concentration of the hydrogen ions they yield, but is specific—hydrochloric, lactic, acetic and sulphuric acids, for instance, are effective in the order named when compared. *The same is true of their effects in eliciting amoeboid motion.*

In the same amount hydrochloric acid is effective at a concentration of N/4, lactic acid at N/2, acetic acid at 1/N. Sulphuric acid is not effective until a concentration of 5/N is reached. In the case of each acid the speed and amount of reaction of the amoeba is increased as the concentration of the acid is increased.

Urea, the amines and the alkalies are among the substances which act as hydrators of proteins. *These all have the property of inducing amoeboid movement.*

A crystal of urea (weight - 0.001 gm.) acts in the same manner as the acids.

Paraphenylenediamine proved to be the most satisfactory of all the agents which I studied. This substance dissolves so slowly that the amoeba may be observed to migrate in the direction of the crystal. The movement is slow and flowing in character and differs in no respect from "normal" amoeboid movement. The amount used was the same as in the case of urea. If, after such treatment, the animal is returned to its normal habitat, it moves in a "normal" manner.

When 5/N NaOH is used in the same manner as the acids, the amoeba responds in the same way.

All inorganic salts antagonize—even without chemical neutralization—the swelling effects of acids upon protein colloids. They do this in a definite order, univalent radicals being less effective than divalent at the same molar concentration, and these than trivalent. *The same is true of amoeboid movement.*

In this group of experiments the amoeba was permitted to come to rest in .3 per cent. sodium chloride solution and then placed in .25 cc of a solution of the salt to be tested; .005 cc of 5/N HCl was used as a "stimulus" in each case. Ferric chloride produces complete inhibition of movement at a concentration of .05/M; calcium chloride and magnesium chloride between .1/M and .2/M; while sodium chloride does not produce this effect until a concentration of .6/M is reached. For any given salt the response of the amoeba to the "stimulus" decreases as the concentration of the salt solution increases.

STANLEY W. WHITEHOUSE
EICHBERG LABORATORY OF PHYSIOLOGY,
UNIVERSITY OF CINCINNATI

BOOKS RECEIVED

CASTELLANI, SIR ALDO. *Climate and Acclimatization.* Pp. viii + 152. 5 figures. John Bale Sons and Danielsson, London. 7s/6d.

FARNHAM, C. MASON. *Determination of the Opaque Minerals.* Pp. vii + 236. McGraw-Hill. $3.50.

RAYLEIGH, LORD. *Lord Balfour in his Relation to Science.* Pp. viii + 46. Cambridge University Press. Macmillan. $1.00.

THWING, CHARLES F. *American Society.* Pp. ix + 271. Macmillan. $2.25.

WOODMAN, A. G. *Food Analysis: Typical Methods and the Interpretation of Results.* Third edition. Pp. xii + 557. 110 figures. McGraw-Hill. $3.50.

SCIENCE

VOL. 73 FRIDAY, MARCH 27, 1931 No. 1891

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE ORIGIN OF LIMESTONE CAVERNS

By W. M. DAVIS

PROFESSOR OF GEOLOGY, EMERITUS, HARVARD UNIVERSITY

INTRODUCTION

CAVERNS in massive limestones are usually more or less filled with dripstones, and thus exhibit the work of two contrasted processes: excavation and replenishment. The first process, as generally understood in the United States, is taken to be the solutional work of percolating vadose water (water descending from the land surface to the water table) associated with the corrasional work of vadose or water-table streams. No adequate explanation for the change of process from excavation to replenishment is usually given with this explanation.

Another explanation of caverns was proposed by Grund in 1903.[1] He suggested that they are the solutional work of ground water below the water table during a lower stand of the cavern region; and that when the water filling is withdrawn in consequence of regional elevation, dripstone deposition begins.

I have attempted to work out the consequences of these two rival explanations, with special attention to their application in regions of level-bedded limestones; and then to confront the unlike consequences with facts of observation in the hope of determining which explanation works best. A fuller discussion of the problem is presented in the *Bulletin* of the Geological Society of America for 1930. The statement here given is assertive rather than argumentative.

CAVERNS EXCAVATED ABOVE THE WATER TABLE

The joints and bedding planes in a mass of recently uplifted, level-bedded limestones are here assumed to be close-fitting. Minute water ways will be opened along them, especially on lines of intersection, and a complex, angular, three-dimensional network of tube-

[1] Alfred Grund, "Die Karsthydrographie." *Penck's Geogr. Abhandl.*, 7, 103–200, 1903.

like crevices will be thus developed. At an early stage the crevices may be water-filled nearly to the land surface, because their narrowness makes water movement through them very slow; and during this stage it is ground water rather than vadose water which occupies them. But as subaerial valleys are deepened and as the lower paths of the sheet-like crevices are enlarged to linear passages, the water table will sink to the levels of near-by valley floors. All the crevices and passages above it will thereafter be occupied only by vadose water and ground air.

When the passage diameters reach or exceed those of a stove pipe or a barrel the passages may be called shafts and galleries. Then vadose streams, running with free surface on gallery floors and carrying some sediment from surface sinks, will corrade as well as dissolve the bed rock. The streams in the higher galleries will be segmented wherever new shafts are opened, and the further enlargement of such galleries will be much retarded. But at the same time the lowest galleries, nearly coincident with the water table, will be actively enlarged by their growing streams. A process of natural selection then becomes operative, by which the three-dimensional network of water passages, earlier opened at various levels, will be reduced to a two-dimensional branchwork at the lowest levels; and the branch-work galleries will then be worn down to grade with respect to the valley floors into which their streams discharge. The subterranean branch-work will resemble that of a subaerial stream system in having many small and slender twigs near its divides, where the amount of water available for their maintenance is small, and in the down-stream union of many twigs and branches in a trunk.

As this work advances the high-level galleries, little enlarged, may be nearly filled by deposition of calcite. Furthermore, solution in the lower galleries will probably be exceeded by corrasion; for the streams will cut downward until grade is reached, and laterally thereafter. At the same time solution will be lessened, because with the development of surface sinkholes the shafts at their bottom will so promptly receive most of the rain water that it will be little carbonated. Besides, solvent action by vadose trickles ceases when they become saturated, but corrasion continues as long as sediment-bearing streams run. It seems therefore that the part played by carbon dioxide in cavern excavation has generally been exaggerated.

When good-sized, low-level branching galleries are thus excavated, their floors should be worn down to even gradients; rock falls from roof and walls may cause local and temporary irregularities. But the walls and roof should not show marks of stream wear, because early-made marks of this kind would be removed by rock falls during gallery enlargement. The side walls may, however, show flutings formed by the solvent action of vadose trickles; but such flutings are subject to intermittent removal by rock falls.

During all these changes the branchwork pattern of the streams and their galleries will be more and more perfected. The general acceptance of this view is illustrated in the following passage by Meinzer regarding the underground drainage of limestone regions:

> Percolating water gradually dissolves and removes the limestone and thus produces large underground channels [galleries]. By this process a system of underground drainage may be developed which is comparable to a surface drainage system in another [non-soluble] terrain. The underground streams, like the surface streams, become adjusted to some base level, such as the sea, a lake, or a major surface stream, into which they discharge, and they tend to become graded to this base level by the laws of stream gradation.[2]

In the meantime the general down-wear of the land surface, especially on the slopes of growing sinkholes, will convert the originally even upland into a mature or karst surface of deep hollows separated by sharp edges, peculiar to limestone regions. Then as such down-wear continues and the karst forms are subdued, the ever-enlarging, low-level galleries will be locally converted into open or blind valleys by the collapse of their roofs and the gradation of their walls. Eventually all the roofs will be removed, all the walls will be worn down, all traces of the caverns will vanish and a nearly featureless peneplain will result.

The opportunity for dripstone development offered by the main galleries of such caverns is not good, even at their maturity, because their ground air is moistened by the streams. It should be noted that, under this explanation of caverns in level limestones, their excavation is the work of only one cycle of erosion; indeed, of only the youthful and mature stages of one cycle, for during the older stages the previously excavated caverns are destroyed. Caverns thus formed are therefore at their best during the karst stage. However, if a limestone region in that stage of its cycle suffers regional elevation, in consequence of which new branchwork caverns are developed at a lower level than before, the first-formed, upper caverns will be deserted by their streams, and dripstone deposition will then, as Weller has shown,[3] go on apace before the upper caverns are unroofed by general surface degradation.

[2] O. E. Meinzer, "Relations of Ground Water Conditions to Leakage of Reservoirs." *Am. Inst. Min. Engrs. Tech. Pub.*, 215, 1929.

[3] J. M. Weller, "The Geology of Edmondson County . . . [Kentucky]." *Ky. Geol. Surv.*, 1927.

CAVERNS EXCAVATED BELOW THE WATER TABLE

Following King's results[4] it would seem that, at an early stage in a cycle of erosion, ground water may make a deep descent beneath uplands before its ascent toward discharging springs in valley floors is begun. But when maturity is reached in a limestone region, much underground water may flow as water-table streams without making so great a descent. Yet even then some of it must circulate slowly at greater depths. This is assured by the depth at which water is encountered in deep wells. For example, Bain mentions[5] a well 1,750 feet deep in a valley that is 750 feet below the adjacent limestone uplands in southern Missouri, and infers a circulation to a depth of 2,500 feet beneath the uplands. It is the solvent action of this deep and slow moving ground water that is now to be examined.

As with vadose water the movement of ground water must be at first chiefly along intersections of joints with each other and with bedding planes. A complex, angular, three-dimensional network of fine crevices will therefore be developed in this case also, but more slowly than by vadose water, because deep-lying ground water is almost stationary; also because deep-descending water will be partly charged with calcite at the beginning of its descent. The fine crevices will, however, be gradually widened into shafts and galleries, all of which must remain water-filled, to whatever size they grow. Unlike the high-level crevices and passages in the network above the water table, none of the low-lying crevices below the water table will be deserted, however small they are, by the withdrawal of water to lower and larger ones. All will continue to grow. Hence the three-dimensional network will here be preserved, instead of being converted into a two-dimensional branchwork. But like the vadose branchwork, the ground-water network should be of smaller dimensions near the divides and should increase in size toward the main valleys. Yet unlike the vadose branchwork, gallery floors here will not be graded; they may ascend and descend somewhat irregularly.

Narrow and deep galleries may be dissolved out along master joints, but their angular turns from one joint to another need not be rounded off, as they should be if similar joints are followed by vadose streams at higher levels. Broad and low galleries may be dissolved out on especially soluble layers; and several such galleries may be developed simultaneously at different levels. Their breadth will be determined largely by the strength of their roof. Rock falls from roof and walls may take place as galleries are enlarged; hence both roof and walls may have forms of two kinds: forms of solution, whatever such forms may be, and forms of fracture. The fallen blocks will be gradually dissolved away, and the first-fallen, lower members of a slowly growing heap should be most rounded by this process. In large galleries the later fallen blocks should rest on a floor of clay, the insoluble residue of the dissolved limestone; and when such a floor cover is well developed, further enlargement of the gallery should be only upward and laterally. No dripstones can be formed while the water-filling is present; but if the solvent power of a saturated water-filling is diminished by any cause, crystals of calcite may be deposited on the walls, thus making the cavern resemble an immense geode.

[4] F. H. King, "Movement of Ground Water." *Nineteenth Ann. Rep. U. S. Geol. Surv.*, 1899, Pt. 2, 59–294.

[5] H. F. Bain, "Lead and Zinc Deposits of the Ozark Region [Missouri]." *22nd Ann. Rep. U. S. Geol. Surv.*, Pt. 2, 23–227, 1901.

The time factor is here of great importance. The excavation of deep-lying caverns in a limestone region by ground-water solution may continue during an entire cycle of erosion, during which so much of the upheaved limestones as stand above peneplain level will pass through all the changes of surface and cavern forms described above, until peneplanation is reached. As calcite is soluble in about 70,000 times its volume of non-carbonated water, the increasing volume of ground water in a growing cavern must be changed many thousand times during the cavern growth. But as the duration of a cycle of erosion may well be several million years, the time available for these changes in a cavern beneath a peneplain is enormously long. At least several months may be allowed for the supply and withdrawal of the water in crevices an inch in width, and in passages of knitting-needle or stove-pipe size during early stages of growth; and one or more centuries in great galleries at late stages of growth. Such periods of time would seem long enough for the ground water to become saturated. In the tomb-like stillness of large galleries, solution in slow-moving water may be aided by diffusion and also by a slow convection, due to the sinking of saturated water in contact with roof and walls and its replacement by less saturated water from below. Moreover the quick descent of rain water down sinkhole shafts during maturity will be changed in the later stages of a cycle, when the land surface is subdued to low relief or worn down to a peneplain, to a slow percolation through the residual soils, and the descending water will then have a good chance of becoming carbonated. Furthermore, the water table then lies so little below the surface that the descending water need not have become saturated when it reaches that level, and will therefore continue its solvent action at lower levels. On the other hand small differences of head beneath a peneplain will retard ground-water circulation and thus lessen its solvent power; but with increasing size of shafts and

galleries a given head will cause a less sluggish circulation.

In case some of the ground water, coming from deep sources, is more or less charged with carbon dioxide, as Emmons has suggested in his study of ore-filled cavities in the limestones of the Mississippi Valley,[6] the rate of cavern excavation would be accelerated; and in such cases, the escape of some of the carbon dioxide in consequence of diminution of pressure with ascent might provoke deposition of calcite crystals on the cavern walls, as has been noted.

The withdrawal of the water-filling from ground-water caverns may be brought about in two ways. During the later stages of an erosion cycle, especially in a region several hundred miles inland from its river mouths, the slow continuance of degradation must lower the valley floors to fainter and fainter gradients, and the associated water table will then also be lowered, so that caverns which were previously below it will now be left above it, and their water-filling will thereupon be discharged. But the same result is more efficiently brought about by regional elevation, as Grund pointed out. If this takes place after peneplanation the old rivers, rejuvenated, will during and after the elevatory movement erode new valleys, and the caverns that are tributary to such valleys will be drained. It is quite possible that some caverns may then have roofs so thin that they will collapse when the water, which aided in sustaining it then, is drained away. Such caverns will soon assume the form of valleys, open or blind. They should not be expected near the peneplain divides.

As soon as ground-water caverns thus come to be occupied by ground air, their replenishment with dripstones may begin, except in the lowest galleries where the ground air is dampened by streams. At the same time the streams will attempt to convert any network in their courses into a branchwork; but as this attempt is not made until the cavern galleries are of good size, it will have little or no effect on them, especially on the higher galleries, in which the network will therefore survive.

Facts to be Accounted For

All our greater caverns are in uplifted and more or less dissected peneplains. Under the theory of excavation by vadose water, these caverns must have been excavated and their dripstones deposited within them since the upheaval of their regions. Under the theory of excavation by ground water, they should have been produced before the elevation of their region, during the previous cycle of peneplanation, and only subordinately modified, chiefly by dripstone deposition, since their elevation.

All our larger caverns have galleries of a pronouncedly network pattern. This is wholly inconsistent with the requirements of the current theory of vadose excavation, but perfectly consistent with the alternative theory of ground-water excavation. And if great network caverns have been thus excavated, smaller caverns of simpler pattern may have been similarly excavated.

Three caverns in a much degraded part of southern Indiana, with some network loops in their galleries as described by Malott,[7] appear to illustrate successive stages in the withdrawal of a former water-filling as a result of slow valley deepening, independent of regional elevation.

Some linear caverns in the same state, described by Malott[8] and by Addington,[9] exhibit angular turns, suggestive of quiet, immature solution by ground water on intersecting joint planes, rather than of stream corrasion.

The walls and roofs of certain caverns exhibit peculiar rock forms that are much more suggestive of solution than of corrasion.

A few caverns are known in which the walls are studded with calcite crystals, some of which are over a yard in length. One of these caverns in Missouri[10] and another in Arizona[11] were water-filled when first found, but they have been emptied by pumping in the course of mining operations. A third in the Black Hills had been naturally drained; its crystals are described as in part covered by dripstones.[12]

The floors of cavern galleries are by no means always graded. The broad floor of a large gallery in Carlsbad cavern, New Mexico, has a pronounced slope.[13]

As far as these varied facts go, they discredit the theory of excavation by vadose water and give good support to that of ground-water excavation. But it is still eminently possible that certain caverns of simple pattern are of vadose-water origin.

Caverns in Inclined Limestones

Several important caverns in the inclined limestones of the Appalachians have, as described by Hovey[14]

[6] W. H. Emmons, "Sulphide Ores in the Mississippi Valley." *Econ. Geol.*, 24, 221–271, 1927.

[7] C. A. Malott, "Three Cavern Pictures." Proc. Ind. Acad. Sci., 38, 201–206, 1929.

[8] C. A. Malott, "Physiography of Indiana," in "Handbook of Indiana Geology." Ind. Dept. Conserv., p. 236, 1922.

[9] A. R. Addington, "Special Topographic Features . . . Bloomington, Indiana, Quadrangle." Proc. Ind. Acad. Sci., 38, 247–261, 1929.

[10] Arthur Winslow, "Lead and Zinc Deposits." *Mo. Geol. Surv.*, 7, 566, 1894; also, Bain, as above, 109, 110.

[11] J. B. Tenney, personal communication.

[12] E. O. Hovey, "Crystal Cave of South Dakota." *Sci. Amer. Suppl.*, 57, 23657–23658, 1904.

[13] This statement is based on a detailed topographic map made for the National Geographic Society by R. H. Runyan on a scale of 50 feet to an inch, with 5-foot contours on the gallery floors.

[14] H. C. Hovey, "Celebrated American Caverns." Cincinnati, 1882. 2nd. ed, 1896.

and by Reeds,[15] well-developed gallery networks, highly suggestive of excavation by ground-water solution; but they possess also one or more well-defined levels, independent of their bedding planes, and suggestive of control by water-table streams during pauses in regional elevation. How these levels are to be explained, and whether they have been determined by thrust planes I can not say.

Observational Study of Caverns

It is desirable that caverns should be studied with especial attention to the detailed form of their rock walls and to the general pattern of their galleries. During such study the attempt should be made to explain every element of their form by each one of the afore-discussed theories. Care should be taken not to be distracted from the primary study of cavern excavation by the secondary fascinations of dripstone replenishment. Each of the two theories should be impartially considered in its relation to the physiographic evolution of the cavern district, and a provisional place should be found under each theory for every cavern feature, large and small. Thus in time a good theory of limestone caverns may be established.

EDGAR FAHS SMITH: PROVOST, CHEMIST, FRIEND

By CHARLES FRANKLIN THWING

PRESIDENT EMERITUS OF WESTERN RESERVE UNIVERSITY

Often have I wished I might make a book seeking to interpret the most loved teachers of our colleges. What a rich treasury it would indeed be of dear souls loving and loved. In it I would tell of "Old Peabo" of Harvard, who embodied the great phrases of Paul's eulogy on charity. Included, too, would be Shaler, also of Harvard, of whom it was said, "Late in life he was fond of telling the story of his once having overheard two students talking together. 'Where's the old man?' asked one. 'Hush!' said the other, 'if he hears you call him old man, he'll walk your d—d legs off.'"[1] Chief among the worthies would be North of Hamilton, whose other and more affectionate name was "Old Greek." Of him a graduate wrote, "Professor North, I love you because you inspired in me a desire to do my best and to realize in my life what God has made possible."[2] Of course, too, a place would be had for Garman of Amherst. Of Garman Principal Stearns of Andover has written:

> To him hundreds of Amherst men owe the best inspiration of their lives. Those who have enjoyed the privilege of sitting as disciples at his feet realize as none others can what a rare privilege has been theirs. He taught us the beauty of truth. Through him the spiritual world was brought near and its glory revealed. He made us feel the presence of the Divine within us, and he stirred as few men have been able to do within the hearts of his pupils the desire to serve. The wonderful influence he exerted over the minds and lives of his students was unique in the educational world. Sluggish minds were stimulated to activity; careless minds were taught the value of accuracy; indifference was changed to eager desire. To many an Amherst man the most sacred and cherished memory of college days will always be that morning hour in Walker Hall where intellect was quickened and ambition aroused.[3]

The interpreter also would not leave out Wright of Middlebury, who held higher hope for his students than they had for themselves. One of these students wrote to him saying, "I am trying to catch up with your ideals for me." In the list I should want to include from a wholly different zone Osler, the teacher of medical students in three universities, Jowett of Baliol, and Tholuck of Halle, a theologian gifted with wit and humor, and with paternal love for his students.

Yet as noble, as inspiring, as formative, as loved, and as loving as any other of the noble group is Edgar Fahs Smith. Of the fourteen provosts in the university I have known four: Pepper, the refounder, the inspiring teacher; Harrison, the watchful and insistent financier; Penniman, the present head, the faithful conservator and the broad-minded administrator; and Smith, whom Penniman succeeded, and of whom I now write in a way most personal.

On the campus of the University of Pennsylvania, within sight of a laboratory which he planned and in which he worked, stands a statue bearing this inscription:

[15] C. A. Reeds, "The Endless Caverns of the Shenandoah Valley" [Virginia]. New York, 1925.

[1] "The Autobiography of Nathaniel Southgate Shaler," p. 369.

[2] S. N. D. North, "Old Greek. A Memoir of Edward North with Selections from his Lectures," p. 138.

[3] Eliza Miner Garman, "Letters, Lectures and Addresses of Charles Edward Garman," p. 581.

EDGAR FAHS SMITH
Provost 1911–1920
Teacher Inventor Friend

The four words represent the four-square relation of his life. Each word, illuminating, represents either the service he gave, or the contribution he made, or the relations he held. I can not but believe, however, that the last word, Friend, is the more and most important.

The nine years of his provostship were perhaps the most trying of all the decades of his life. He accepted the great office and undertook its duties under the earnest persuasiveness of the board of trustees. He was reluctant to give up his daily and double work of teaching and of research. Technically, during his administrative period, he continued his professorship. The opportunities of the professorship were his life. He, however, accepted the provostship under the promise, as he understood, that he should have no responsibility for the financial relationships of the university. Especially did he insist that he should be free from any specific or implied duty of raising funds either for endowment or for meeting current expenses. For such undertakings his immediate predecessor, Harrison, had peculiar power. Hardly, however, had he been placed in the provostship when it became plain that the trustees were relying on him for important financial duties. He once said to me, with tears in his voice, "It almost killed me." Possibly one might soberly say that the financial condition became a cause which ultimately contributed to his early death.

Of course one might add that Smith should have known! For he is not the first of college presidents who has learned that honest and high-purposing boards of college trustees allow themselves to give happy promises of immunity from specific labors in financial administration to a newly elected president, promises which it seems later so easy to forget or to neglect.

Yet it is as teacher, as investigator and as friend that, as declares the monument, the personality is most beautiful and preeminent. This trinity of great forces and qualities are wonderfully joined together in a noble unity of personality. Edgar Smith's service as teacher opened the door to friendships, and the friendships ministered unto his work as a teacher. His teaching, too, was constantly reinforced by his researches, and his teaching contributed certain human impulses unto his investigations. His work was indeed a unity, as his personality was a unit. Too many teachers make their teaching and their personality independent parts of their one character. Such divisions or subdivisions are, or at least should be, impossible.

But to these three constructive elements are to be added—and the addition could have fittingly been written on his monument—his service as a writer. For his books, biographical and theoretical, were the normal expression of the studies of the laboratory and of the library. Their number is indeed colossal, and their variety nothing less than immense.

This is not the place to give in detail the contributions which he made, through writing and research, to chemistry organic, inorganic, analytical, electro and historical. To name even the investigations, the experiments, the discoveries, would bear both the writer and the reader too far afield. Perhaps the most important contributions were those devoted to electrochemistry,

> . . . a domain in which he was a pioneer and soon became a recognized leader of international reputation. In the hands of this master craftsman, the electric current became a tool of undreamed usefulness and possibilities, opening up wholly new methods of analysis, separation and determination. About half of all the research papers he published were based upon new applications of the electric current. His introduction of the rotating anode together with the employment of currents of high amperage and high voltage marked a new epoch in the development of electroanalysis. His books on electrochemistry quickly became and have since remained the standard texts in this country, while the Harrison Laboratory was soon known throughout the world for its leadership in this branch of chemistry.[4]

His biographies of chemists, too, numbered more than a score, and his interpretations of chemistry historical and theoretical almost an equal number.[5]

To the scholar even, and to one who is not a scholar,

[4] SCIENCE, May 31, 1929, p. 560.

[5] Separate books, brochures or articles have been published by him concerning the following chemists: Theodore G. Wormley, Jr. (1897); Robert Empie Rogers (1905); George F. Barker (1907); Fairman Rogers (1909); Robert Hare, an American chemist (1917); James Woodhouse (1918); James Cutbush (1919); Franklin Bache (1922); James Curtis Booth (1922); Samuel Latham Mitchill (1922); Charles Baskerville (1923); Martin Hans Boye (1924); John Griscom (1925); James Blythe Rogers (1927); Priestley in America (1920); Priestleyana (1922) and the Priestley Medal Lecture (1926). More general treatises, written wholly or largely from the historical point of view, were: "Chemistry in America" (1914), "Men of Science from the Keystone State" (1914), "Chemistry in Old Philadelphia" (1918), "The American Spirit in Chemistry" (1919), "Progress of Chemistry" (1921), "Our Science" (1922), "A Half Century of Mineral Chemistry in America, 1876–1926" (1926); "Observations on Teaching the History of Chemistry" (1926), "Early Science in Philadelphia" (1926), "Fragments Relating to the History of Chemistry in America" (1926), "A Look Backward" (1927), "A Glance at the Early Organic Chemistry of America" (1927) and "Old Chemistries" (1927). SCIENCE, May 31, 1929, p. 564.

it is inevitable that the thought and heart turn to Smith as a friend. For as a friend I knew and loved him. As an adopted son of the University of Pennsylvania I join with tens of thousands of the real sons of Alma Mater in declaring that he was chief among our dearest. Toward him one has the feeling which an American soldier declared in saying that he went to France for flag and for country, but that he went over the top for mother. For Smith helped his students to carry chemistry into life. Its methods were life's methods, its principles life's principles, its prophecies, its rewards prophetic of life's happiness. To his students he was at once a father and an elder brother. Their sorrows were his sorrows, their triumphs his triumphs, their achievements gave to him a sense of glory, with their slowness of advance or their rapid progress he sympathized, and in the rapidity and height of their advancements he rejoiced. His simplicity, his altruism, his sense of reality, his sturdy honesty, the depth of his thoughtfulness, the breadth of his tolerance, his vision of ideals, inspired, quickened, moved his students. His devotion to them was structural and formative in manhood. He was their friend. He wrote, as a last sentence to his interpretation of Wetherill, "He was one of those Golden Natures who help us form Ideals of Life." The sentence itself we have a right to think of as autobiographic.

OBITUARY

MEMORIALS

THE Edgar Fahs Smith Memorial Collection in the History of Chemistry, which was presented to the University of Pennsylvania two years ago, has been endowed by Mrs. Edgar F. Smith. The collection has been placed in the Harrison Laboratory of Chemistry, and comprises rare books in chemistry, portrait prints and engravings, manuscripts and autograph letters. A catalogue is in course of preparation and will shortly be available for distribution. Miss Eva V. Armstrong, who was formerly Dr. Smith's secretary, has been appointed curator.

A PORTRAIT of Dr. William Stewart Halsted, until his death in 1922 professor of surgery in the Johns Hopkins University, painted by Mr. Casilear Cole, has been presented by Dr. Halsted's family to the Duke University School of Medicine and Hospital. One of the surgical wards of the Duke Hospital is named Halsted Hall.

A BUST of Carl Friedrich Gauss, the distinguished mathematician and physicist, has been placed in the Massachusetts Institute of Technology in memory of his great-grandson, Carl Friedrich Gauss, an alumnus of the institute in the class of 1900. The bust, originally sent by the German Government to the Chicago World's Fair in 1893, was recently presented to the institute by the mother, sister and brother of the late Mr. Gauss.

A TRUST fund for botanical research has been established at the University of Minnesota as the result of a request made by the late Dr. J. Arthur Harris a year ago on his death-bed. He asked that nothing be spent on flowers for his funeral, but that the money be put into a trust fund for research in botany. The fund, contributed by university staff members and others, now amounts to $1,066. Dr. Harris was head of the department of botany of the University of Minnesota and was also connected with the Agricultural Experiment Station. He was an authority on biometrics, and one of the four authors of "The Measurement of Man," a study in that field adopted by the Scientific Book Club last summer.

RECENT DEATHS

DR. JOHN HENRY COMSTOCK, emeritus professor of entomology at Cornell University, died at Ithaca on March 20, after a prolonged illness. He was eighty-two years old. Mrs. Comstock, also professor emeritus at Cornell University, died last year.

CAPTAIN HENRY MARTYN PAUL, assistant astronomer at the Naval Observatory from 1875 to 1880 and from 1883 to 1897, professor of mathematics in the U. S. Navy from 1897 to 1913, died on March 15, at the age of eighty years.

DR. EDWARD VERNON HOWELL, founder of the School of Pharmacy of the University of North Carolina, and dean for thirty-three years, died on February 14, at the age of fifty-nine years.

FRANK M. DORSEY, formerly chief of the development division, Chemical Warfare Service, died on February 10, at the age of fifty-two years.

THE death is announced at the age of forty-six years of Dr. Paul Trendelenburg, professor of pharmacology and director of the Berlin Pharmacologic Institute.

PROFESSOR ENRICO SERENI, head of the department of physiology at the Naples Zoological Station, died suddenly on March 1. He was thirty-one years old.

Nature reports the death of Mr. J. D. H. Dickson, senior fellow of Peterhouse and author of numerous papers on thermodynamics and thermoelectricity, on February 6, aged eighty-one years; of Mr. D. T. Jones, chairman of the Fishery Board for Scotland, on February 4, aged sixty-five years, and of Dr. Albert Schamelhout, secretary of the International Pharmaceutical Federation, on January 20, aged sixty years.

SCIENTIFIC EVENTS

AN AGRICULTURAL RESEARCH INSTITUTE FOR PORTO RICO

A NEWS bulletin of Science Service calls attention to the circumstance that President Hoover's visit to Porto Rico may revive interest in the establishment of a graduate school of tropical agriculture on the island, a project in which Governor Theodore Roosevelt is greatly interested. Pointing to the achievements of the school of tropical medicine which was established on the island in cooperation with Columbia University, Governor Roosevelt states his belief that Porto Rico is peculiarly fitted to become a great center for Pan-American research and learning.

Cornell University, in whose school of agriculture many Porto Rican boys have studied, is particularly interested in the proposed graduate tropic-agricultural school, and is expected to cooperate in its founding and maintenance. The National Research Council some years ago recommended such an institution. Subsequently members of the committee of biology and agriculture of the council visited Porto Rico and unanimously decided that it would be the logical place to establish such a school.

There is at present a good department of agriculture in the University of Porto Rico, graduates of which are more and more in demand in South American countries for special consultant and advisory work.

In 1926, Commissioner Carlos E. Chardon went to Colombia to make a survey for the agricultural school at Medellin, and, following the publication of his report, Colombia asked three graduates of the Porto Rico University to come there as teachers. Later an agricultural experiment station was built and equipped in the Department of Valle del Cauca in Colombia under Porto Rican guidance, and two former directors of the Porto Rican Agricultural Experiment Station were offered good consultant positions with sugar companies in Cuba, Santo Domingo and Peru.

Another result of the agricultural expedition to the Cauca Valley was a large collection of parasitic flora and the publication of a pamphlet called "Mycological Explorations of Colombia," which is in great demand among botanists.

Last year Ecuador sent its director of agriculture, Dr. Abelardo Pachano, a Cornell graduate, to Porto Rico to study agricultural research and experimentation. Dr. Pachano took two Porto Rican university agricultural graduates back with him to Ecuador. Venezuela, Panama and Peru have also offered positions to Porto Rican specialists in agriculture.

Because of the Spanish culture, language and tradition in the lives of Porto Ricans, Governor Roosevelt holds that the islanders are admirably adapted to act as intermediaries between the United States and South American countries on diplomatic missions. A still firmer basis of international understanding can be brought about, he believes, through help such as Porto Ricans now are rendering to South American countries along scientific lines.

For that reason, Governor Roosevelt hopes that the graduate tropic agricultural school on the island sponsored by Cornell University may soon become a reality. Soil possibilities of many of these south and central American countries are so varied that the day may well come when a wide variety of northern fruits and vegetables will be produced for home consumption in the tropics, as well as coffee, tobacco, pineapples and other tropical foods for export.

VIRGIN FOREST LANDS OF THE UNITED STATES

THE area of virgin forest lands in territory now within continental boundaries of the United States was approximately 800,000,000 acres at the time Columbus came to America and is now less than 100,000,000 acres, according to estimates made available on March 10 by the Forest Service and summarized in the *U. S. Daily*.

By far the greater portion of the decrease is attributable to clearings made to provide acreage for farms, particularly in the eastern section of the country. The area cleared to make way for agricultural operations since the beginning of the twentieth century is comparatively small, it was pointed out.

The estimates represent results of efforts to obtain the closest possible approximations in the face of absence of conclusive data, it was emphasized.

The total area of forest land in the United States, exclusive of Alaska, reached by forest fires in 1929 was 46,230,120 acres. Of this total 4,876,320 acres were located in protected areas while 4,353,800 acres on which fires occurred were not within sections over which organization for protection against fire has been established. The total amount of forest lands needing protection against fire is estimated by the Forest Service at 580,809,240 acres. Approximately two thirds of this acreage is protected.

A compilation made in 1923, showing little need for revision in later years, placed the amount of timber affected by the presence of insects at 9,000,000,000 board feet. This estimate includes not only the trees killed by bark beetles and defoliating in-

sects but also timber damage caused by borers and other insects which caused reduced timber values, affected chances of forest reproduction and impeded the growth of trees. A large amount of timber damaged by insects lends itself to salvaging operations.

The annual loss by decay has been estimated to be 300,000,000,000 board feet. Timber losses caused by erosion of soil are small, since the presence of tree stands are a protection against erosion, except in small areas, such as the banks of streams.

Although timber is being cut from some land to permit extension of farm areas, the amount of land formerly used for farming and allowed to revert to classification as "forest land" is larger. Any losses of timber resources that otherwise might take place are thus offset.

The Forest Service is now making a survey of forests in the United States which will require several years for completion. Survey work already has advanced in the Pacific Northwest region and in some other sections.

THE FIELD MUSEUM OF NATURAL HISTORY

THE annual report of Mr. Stephen C. Simms, the director of the Field Museum of Natural History, a book of 256 pages with twenty photogravure illustrations, has been issued. The museum was the recipient of a number of noteworthy benefactions during the year. Gifts received for various purposes include $154,547 from Mr. Stanley Field, president of the institution; and $166,000 from Mr. Marshall Field, of New York, a trustee.

After allocation of all contributions, and all income from the museum's endowments and other sources, the museum ended the year with an unprovided for operating deficit of $114,898. Total expenditures for the year, including general operating expenses, purchases of collections, cost of expeditions (excluding those privately financed for the museum by various sponsors), equipment, the N. W. Harris Public School Extension of the Museum, and the James Nelson and Anna Louise Raymond Foundation for Public School and Children's Lectures, amounted to $920,110. Mr. George A. Richardson was elected a trustee to fill the vacancy on the board caused by the death of Chauncey Keep.

Mr. Simms reports that the museum received 1,322,799 visitors during the year, and in addition, outside activities conducted by its units known as the N. W. Harris Public School Extension, and the James Nelson and Anna Louise Raymond Foundation, reached approximately 716,000 children in the schools, at camps, community centers and elsewhere.

The report gives detailed accounts of the work of seventeen expeditions which the museum had in operation both in this country and in distant parts of the world during 1930. Most important of these were the Vernay-Lang Kalahari Expedition, the Field Museum Archeological Expedition to the Southwest (financed from a fund established by Julius Rosenwald and the late Augusta N. Rosenwald), the two Chancellor-Stuart-Field Museum Expeditions to the South Pacific and to Aitutaki (Cook Islands), an expedition to Africa sponsored and led by Captain Harold A. White, of New York, and Major John Coats, of London; an expedition to India sponsored and led by C. Suydam Cutting, the Field Museum-Oxford University Joint Expedition to Kish, Mesopotamia, the Frederick H. Rawson-Field Museum Ethnological Expedition to West Africa and the Marshall Field Botanical Expedition to the Amazon.

A new exhibition hall devoted to marine mammals was opened, and throughout the museum a large number of new exhibits illustrating anthropological, botanical, geological and zoological subjects were installed. Work was begun on preparation of two new halls which will be devoted to comprehensive exhibits relating to prehistoric man and to physical anthropology. Hundreds of gifts of material for addition to exhibits and study collections were received from donors located in all parts of the United States and many foreign countries.

THE AMERICAN PHILOSOPHICAL SOCIETY

THE American Philosophical Society, Philadelphia, will hold its annual meeting on April 23, 24 and 25. The president, Dr. Francis X. Dercum, and the vice-president, Dr. Henry Norris Russell, of Princeton University, will preside over the session. Dr. Russell will give the evening lecture on "The Chemistry of the Stars." The annual dinner will be given at the Bellevue-Stratford Hotel on Saturday evening. A large number of papers will be presented on the opening day and a symposium has been arranged on "The Changing World," which is as follows:

SECTION I. TENDENCIES IN THE NATURAL SCIENCES

"The Astronomer's Goal": Frank Schlesinger, director of the Yale University Observatory.

"The Assault on Atoms and Molecules": Arthur H. Compton, professor of physics, University of Chicago.

"Hopes in the Biological Sciences": William Morton Wheeler, professor of entomology and dean of the Bussey Institution for Research in Applied Biology, Harvard University.

"Lengthening the Span of Life": Lee K. Frankel, second vice-president of the Metropolitan Life Insurance Company. (Introduced by Dr. Huebner.)

"Technology and Material Progress": Dr. Willis R. Whitney, director of the Research Laboratory of the General Electric Company, Schenectady. (Introduced by Dr. Rice.)

SECTION II. TENDENCIES IN THE FIELD OF THE SOCIAL SCIENCES

"Economic Adjustment in a Machine Age": Ernest M. Patterson, professor and head of the Department of Economics, University of Pennsylvania. (Introduced by Dr. Johnson.)

"Communications and World Peace": Speaker to be announced.

"Unemployment and Its Social Significance": Arthur Woods, chairman of President Hoover's Emergency Committee for Employment. (Introduced by President Dercum.)

"Thou Shalt Not": James M. Beck, Member of Congress.

"Scientific Knowledge and Human Conduct": Speaker to be announced.

SECTION III. THE CHANGING WORLD

"Round Table Discussion and Recommendations": Edwin G. Conklin, professor of biology, Princeton University.

SCIENTIFIC NOTES AND NEWS

THE Executive Committee of the American Association for the Advancement of Science will hold its regular spring meeting at the Cosmos Club in Washington on Sunday, April 26, with a forenoon and an afternoon session. Business to come before the committee at this meeting should be in the permanent secretary's office, Smithsonian Institution Building, Washington, D. C., by April 20.

MAJOR GENERAL A. W. GREELY will observe his eighty-seventh birthday on March 27.

DR. ALEXIS CARREL, of the Rockefeller Institute for Medical Research, has been chosen as recipient of the Dr. Sofie A. Nordhoff-Jung prize for 1930 for his outstanding work in the field of cancer. Dr. Carrel will receive the diploma and a check for $1,000 from Dr. Nordhoff-Jung at ceremonies at Georgetown University on March 28. Ambassador von Prittwitz, of Germany, will read the diploma. Ambassador Claudel, of France, Dr. Carrel's native land, will attend, and Dr. W. Coleman Nevils, president of Georgetown University, will preside. The citation reads: "Dr. Carrel has added new laurels to his great achievements in surgery by expanding the method of tissue culture, and by its objective application he has vastly aided in the elucidation of fundamental questions relating to morbid growth, especially the development of malignant tumors."

ON the occasion of the seventy-sixth birthday of Mr. Andrew W. Mellon, Secretary of the Treasury, on March 24, the American Institute of Chemists announced the award of its medal jointly to Mr. Andrew W. Mellon and Mr. Richard B. Mellon for distinguished service to the science and profession of chemistry. Dr. Frederick E. Breithut, president of the American Institute of Chemists and head of the department of chemistry at the Brooklyn College, in making the announcement, said: "The institute medal is awarded annually for distinguished and outstanding services to the science and profession of chemistry. Mr. Andrew W. Mellon and Mr. Richard B. Mellon have contributed to the advancement of chemistry in its broadest aspects and have fostered the progress of industry by their far-seeing and unselfish efforts. Through the agency of the Mellon Institute of Industrial Research they have been leaders in the great forward march of the American chemical industry. This medal is awarded annually and usually to someone outside the chemical profession itself. In 1929, the award was made to Mr. and Mrs. Francis P. Garvan; in 1930, to Mr. George Eastman."

SIR JAMES HOPWOOD JEANS, who will receive a Franklin Medal from the Franklin Institute, Philadelphia, on May 20, will afterwards spend two weeks at the Mount Wilson Observatory.

DR. J. PLAYFAIR MCMURRICH, professor emeritus of anatomy at the University of Toronto, has been appointed a corresponding member of the Comité Internationale d'Histoire des Sciences of Paris.

DR. KONRAD E. BIRKHAUG, associate professor of bacteriology at the University of Rochester School of Medicine and Dentistry, has been elected a member of the Norwegian Academy of Sciences.

DR. ALBRECHT PENCK, of the University of Berlin, has been elected a corresponding member of the Geological Society of America.

DR. HANS WINKLER, professor of botany at Hamburg, has been elected a member of the Swedish Academy of Sciences.

DR. CARL CORRENS, professor of genetics at the University of Berlin, has been elected a member of the Academy of Sciences at Upsala.

THE National Geographical Society of Cuba, at its annual meeting on March 17, awarded its gold medal to M. Georges Claude, a member of the Paris Academy of Sciences, who has been using the waters of Matanzas Bay to generate electric current from thermal differences.

AT the University of North Carolina Dr. Herman Glenn Baity, professor of sanitary and municipal engineering, has been appointed acting dean of the School of Engineering in the place of the late Dean G. M. Braune.

DR. MONT R. REID, who has been associate professor of surgery in the College of Medicine of the University of Cincinnati, has been appointed head of the department of surgery. Dr. Reid succeeds Dr. George J. Heuer, who leaves at the end of the academic year to become surgeon-in-chief of the New York Hospital and professor of surgery in Cornell University Medical School.

DR. GEORGE R. BANCROFT, of the school of medicine of the University of West Virginia, has been appointed professor of physiological chemistry at Jefferson Medical College, Philadelphia.

DR. JOHN P. NAFE, professor of psychology at Clark University, has been appointed professor of psychology and head of the department at Washington University, St. Louis, effective on July 1, to succeed Dr. Edgar James Swift, head of the department since 1903, who is retiring.

DR. JEFFRIES WYMAN, JR., instructor in zoology at Harvard University, has been promoted to an assistant professorship.

MR. S. A. ROHWER, assistant chief of the Plant Quarantine and Control Administration of the U. S. Department of Agriculture, has been appointed assistant chief of the Bureau of Entomology, to succeed Mr. John E. Graf, now associate director of the U. S. National Museum. Mr. Frank H. Spencer, for the last six years administrative assistant to the Secretary of Agriculture, has been appointed chief of the division of administration in the bureau.

PROFESSOR HOMER G. TURNER has been appointed director of anthracite research for the Anthracite Institute of Lehigh University, and will devote much of his time for the next few years to that work.

MR. E. JACK COULSON, formerly of the department of chemistry of the Kansas State Agricultural College, has been appointed associate biochemist of the U. S. Bureau of Fisheries. He has been assigned to the laboratory of the South Carolina Food Research Commission at Charleston, to work upon the nutritive value of sea foods. The specific problem upon which Mr. Coulson is to be engaged at present deals with the mineral content of the oyster in relation to its value in nutritional anemia.

OFFICERS of the Columbia University Chapter of Sigma Xi elected at the recent meeting for a two-year term are: *President*, Professor Donald E. Lancefield, department of zoology; *Vice-president*, Professor Jerome J. Jerome, department of chemical engineering; *Secretary-Treasurer*, Dr. G. Marshall Kay, department of geology.

AT the meeting of the Pasteur Society of Central California on February 4, the following officers were elected for the present year: *President*, Dr. W. H. Manwaring, professor of bacteriology and experimental pathology, Stanford University; *Vice-president*, Dr. W. T. Cummins, pathologist, Southern Pacific Hospital, San Francisco; *Secretary-treasurer*, Miss Beatrice Howitt, associate in research medicine, Hooper Foundation, University of California; *Councillors*, Dr. C. M. Haring, professor of veterinary science, University of California; Dr. L. B. Taber, doctor of dental surgery, San Francisco. The speakers of the evening were: Mr. B. S. Henry, assistant in veterinary science, University of California, Berkeley, who presented a paper on "Bacterial Dissociation," illustrated with lantern slides, and Dr. J. N. Force, professor of epidemiology, who spoke on "Daniel Sutton and the Revival of Variolation."

AT the request of the American Petroleum Institute, the Secretary of the Interior, Dr. Ray Lyman Wilbur, as chairman of the Federal Oil Conservation Board, has announced the appointment of a Voluntary Committee on Petroleum Economics to survey the supply and demand factors in the petroleum industry for the six-months period beginning April 1 and ending September 30. The committee consists of: E. B. Swanson, chief economist, U. S. Bureau of Mines, chairman; John W. Frey, Bureau of Foreign and Domestic Commerce; Martin Van Couvering, petroleum engineer, Los Angeles; Alfred G. White, National Industrial Conference Board, New York City, and Howard Bennette, Western Petroleum Refiners Association.

DR. O. E. BAKER, of the Bureau of Agricultural Economics, has been requested to assist with the work of the President's Committee on Recent Social Changes, of which Dr. Wesley Mitchell, of the National Bureau of Economic Research, is chairman. Dr. Baker, together with Dr. S. G. Tryon, of the Bureau of Mines, will prepare the portion of the report dealing with natural resources, the former preparing the part relating to land or agricultural resources, and the latter the part on mineral resources. Dr. Baker has been authorized to spend part of his time during the coming year on this work.

AN Associated Press dispatch reports that an investigation of the causes of the recurrence of malaria is planned at the Gorgas Memorial Institute of Tropical and Preventive Medicine at Panama. The tests will be conducted under the direction of Dr. W. H. Taliaferro, professor of parasitology at the University of Chicago.

LEAVE of absence has been granted for the first semester of the years 1931–1932 to Professor William H. Hobbs, of the University of Michigan, who expects to attend the International Geographical Congress to be held in Paris in September of this year and who will carry out certain field studies in geology in addition to completing a book on glaciers which he expects to publish in the near future.

PROFESSOR GEORGE D. HUBBARD, head of the department of geology and geography of Oberlin College, is continuing his work in Europe. He has spent the three winter months in the Balkans and Near East. Maps, photographs and specimens are being collected and sent home for further study and as helps in teaching.

THE HONORABLE S. F. MARKHAM, secretary of the Museums Association of Great Britain, is now in the United States. He plans to visit the larger museums in the eastern part of the United States and Canada.

DR. JOHN C. MERRIAM, president of the Carnegie Institution of Washington, delivered an address on March 19 before the Washington Academy of Sciences on "The Unity of Nature as Illustrated by the Grand Canyon."

DR. FREDERICK G. NOVY, professor of bacteriology in the University of Michigan Medical School, will deliver the annual Kober Lecture at Gaston Hall, Georgetown University, on March 28. Dr. Novy's subject will be "Respiration of Micro-Organisms."

DR. KARL F. MEYER, director of the George Williams Hooper Foundation for Medical Research, University of California, will deliver the seventh Ludvig Hektoen Lecture of the Billings Foundation before the Institute of Medicine of Chicago on April 24. Dr. Meyer will speak on "The Animal Kingdom—A Reservoir of Disease."

DR. HERBERT A. EVANS, of the University of California Medical School, will give the annual Charles Sumner Bacon Lectures at the University of Illinois College of Medicine. The first lecture on March 31 will be on "The Hormones of the Hypophysis," and the second on April 1, on "The Relation of the Hypophysis to the Reproductive System."

THE *Journal* of the American Medical Association reports that Dr. Alfred F. Hess, New York, delivered the Frederick A. Packard Memorial Lecture before the Philadelphia Pediatric Society on March 10, on "Ultraviolet Irradiated Ergosterol and Irradiated Foods," and on March 12 Dr. Warren H. Lewis, Baltimore, presented a motion picture of tissue cultures of human and mammalian tumor cells before the Pathological Society of Philadelphia.

DR. T. A. KIESSELBACH, professor of agronomy in the College of Agriculture, of the University of Nebraska, gave the second series of annual lectures under the Frank Azor Spragg Memorial Fund, early in March, at Michigan State College. This memorial is in honor of Professor F. A. Spragg, who was in charge of plant breeding work at the Michigan Agricultural Experiment Station from 1906 until his death in 1924.

THE Michigan Academy of Science, Arts and Letters held its thirty-sixth annual meeting in Ann Arbor, on March 19, 20 and 21. An extensive program comprising two hundred addresses and papers had been prepared. Professor Edwin G. Conklin, of Princeton, addressed the members on "Fitness the Greatest Problem of Biology"; Professor Leroy Waterman, director of the Michigan-Toledo-Cleveland Expedition in the Near East, spoke on "The Fourth Season at Seleucia on the Tigris." Dr. Eugene S. McCartney, of the University Graduate School, gave the presidential address on "Folklore Heirlooms."

THE 1931 meetings of the American Society of Ichthyologists and Herpetologists will be held at the Academy of Natural Sciences of Philadelphia, from May 11 to 13. The arrangements are in charge of a local committee, consisting of Messrs. Fowler, Dunn and Green. In the business meeting, called for 10 A. M. on Monday, May 11, there will come up for discussion the matter of the support of the *Biological Abstracts* and the *Zoological Record* and other items. Sessions for the reading of papers will be held on Monday and Tuesday. In addition there will be papers of interest to aquarists and an exhibit by Philadelphia fish fanciers. An excursion to the Philadelphia Aquarium and the Philadelphia Zoological Gardens is proposed. Those intending to address the meeting are requested to send titles to Dr. E. R. Dunn, Haverford College, Haverford, Pennsylvania, before May 1.

RECENT meetings of the Toronto center of the Royal Astronomical Society of Canada have included the following lectures: "Star Clusters: Recent Investigations with Reference to Their Bearing on Stellar Evolution," Dr. R. K. Young, Toronto; "Recent Geophysical Investigations in Mineralized Regions," by Professor Lachlan Gilchrist, Toronto, and A. H. Miller, Dominion Observatory, Ottawa; "Telescopes for Amateurs, and How to Use Them," by John A. Marsh, Hamilton, Ontario; "The Sun as a Source of Energy," by Professor D. S. Ainslie, Toronto. The program for March and April includes the following papers: March 24—"The Stars in Navigation," by Commander J. M. de Marbois; April 14—"Some Mathematical Paradoxes," by Professor E. Beatty; April 28—"The Nebulae Outside the Galactic System," by Dr. H. H. Plaskett, Victoria.

Industrial and Engineering Chemistry reports that the British Institute of Metals and the Iron and Steel Institute have been invited by the American Institute of Mining and Metallurgical Engineers to hold their respective autumn meetings in New York in September, 1932, the meetings to be followed by a tour in the United States and Canada. The detailed program for these joint meetings has now been issued. The sessions will begin Monday, September 12, 1932, in the Engineering Societies Building, New York, and the tour of industrial cities will end in Montreal on September 29. The English party will sail from that port on September 30.

THE *Journal* of the American Medical Association reports that the Rockefeller Foundation has offered to assist in the establishment of a School of Hygiene and Public Health in Tokyo. It is said that buildings will be erected at a cost of $5,000,000. The Japanese government has nominated a special committee on organization which consists of Dr. Hayashi, dean of the medical department of the Tokyo Imperial University; Dr. Kitajima, dean of the Keio Medical College, and Dr. Teusler, chief of St. Luke's International Hospital; Chairman, Mr. Akagi, chief of the Sanitary Bureau; Commissioners, Drs. Nagayo and Miyagawa, of the Imperial University of Tokyo and the government Institute for the Study of Infectious Diseases; Drs. Miyajima and Hata, of the Keio Medical College and the Kitasato Institute; Dr. Sato, of St. Luke's International Hospital, and Drs. Kusama and Noheji, of the Sanitary Bureau of the Home Ministry.

THE *Journal* of the American Medical Association reports that the Southern Pacific Company recently offered the use of a completely equipped laboratory on wheels to the University of California Hooper Foundation for Medical Research to assist in answering emergency calls throughout the state for help in fighting epidemics. The car has been rebuilt to fill the needs of a staff of public health workers, either for emergencies or for routine examinations and educational programs, and is available at any time for use anywhere along the railroad's lines. It has a well-equipped bacteriologic and chemical laboratory, an x-ray room with facilities for developing films, a waiting room, examining room, quarters for two physicians and a technician, a galley and combination dining and record room, and quarters for a crew of two. Dr. Karl F. Meyer and Dr. Jacob C. Geiger, of the foundation, have already made use of the car in demonstrations before various medical associations.

LEGISLATIVE appropriations for the support of Kansas State College of Agriculture and Applied Science for the two years beginning July 1, 1931, amount to $2,751,000. They include $40,000 for research on animal diseases, $40,000 for laboratory equipment, $10,000 for continuing the soil survey, $120,000 for branch experiment stations, $44,000 for soil and crop experiment fields and $20,000 for completing the equipment of the college library.

THE bill extending the Adirondack Park to an area of 4,604,000 acres and making it the largest public park in the United States has become law. The park area will now take in 1,550,000 acres, of which 1,201,000 are privately owned and 349,000 state owned. Within the greater park there will be 2,636,000 acres of privately owned and 1,968,000 of state-owned lands.

DISCUSSION

THE IMPORTANCE OF GIVING PAGE REFERENCES IN DESCRIPTIONS OF PLATES

IT may fairly be assumed that it is the desire and intent of authors and editors of scientific publications to render their work as complete and readily usable to the scientific public as possible. There is, however, one point that is too generally overlooked that is believed to be of very essential importance to one who is reading or otherwise making use of a scientific publication. This point is the matter of giving page references in the description of plates. When the paper is a small one, it is of little importance, or even quite unnecessary, but in large papers or monographs the lack of page citations in descriptions of plates entails some, even considerable effort on the part of the reader. If a paper, zoological or botanical, is a systematic one, it may be assumed that the sequence of plates corresponds fairly closely with that of the text. Even then, however, exigencies of the size or character of figures often require considerable irregularity in their order.

When a reader sees a figure on a plate and wishes to consult the text where the figure is described, if no page reference is given, the quickest method usually is to refer to the index. In very many publications, however, no index is given. Lacking an index, the reader must then turn the pages of the text in quest of the desired description of the said figure. If it is a systematic paper on a subject with which the reader is familiar, the required page can usually be found after a moderate search. If, however, it is not a systematic paper but, for example, morphological, then without a page reference or index it may become a serious, even a difficult matter to find the place in the text where a given figure is described.

Recently this difficulty of finding the description of figures in the text was brought home to me strongly in making use of a French morphological memoir with over 300 pages of text and 32 plates. No page references were given in the description of plates and there was no alphabetical index. As I was fortunate enough to possess a copy of the work, it was possible to note the necessary page references on the plates as ascertained by carefully going through the text, but it was a great labor. All this would have been saved and the memoir much improved by simply adding page references in the description of plates.

In doing such work, one may not succeed in finding the description of a given figure. That leaves a student in a quandary. It might be thought, and usually correctly so, that if there is a figure on a plate it is sure to be considered somewhere in the text. On the other hand, I know an author who published many figures that certainly are not considered in the text. To hunt for a description of a figure in the text and not find it, then feel that one must have overlooked it and hunt again, perhaps without avail, but surely with loss of time and vexation of spirit, is most trying. The author of a memoir is in a position to add page references in description of plates with comparatively little trouble, and with an immense gain to the reader. The cost of such insertions is so trifling as to be negligible. Of course it should be borne in mind that in the preparation of manuscript one should write: page, or p. 000, so that space will be available for the printer to insert the required page numbers.

In some publications page references are given in descriptions of plates; as such may be mentioned those of the New York State Museum, the paleontological publications of the United States Geological Survey, and largely in the well-known Challenger Reports. In using such publications it is immediately felt what a convenience and comfort it is to be able to turn directly to the indicated descriptive page without the labor of hunting for the same.

I adopted the method of giving page references in descriptions of plates in my first considerable paper, published some forty years ago, and have employed the same method in what few large papers I have since published with one exception, in which the editor refused to allow page references as they did not accord with the system adopted in that publication. He apparently felt that adherence to system was of more importance than the convenience of the reader.

It appears that there is every argument in favor of giving page references in descriptions of plates, and no argument against it, excepting in so far as the trouble to the author may be considered an objection.

It is highly desirable to have the descriptions of plates facing the plates, but as it costs more, it is not always feasible. When descriptions are printed so as to face the plates, it seems that it would be very desirable to give such descriptions page numbers, as is done in some publications. The main object of this is that a subsequent writer who may wish to refer to them may do so by quoting the *page number*, rather than by the alternative of *page facing plate blank*, which is somewhat lengthy and cumbersome.

Another point that is worth consideration is that in an index to a publication, when an item has references to two or more pages in the text, it is of convenience to have the principal reference indicated by heavy-faced type. Such a method, where adopted, facilitates the finding of the principal reference.

ROBERT TRACY JACKSON
MUSEUM OF COMPARATIVE ZOOLOGY,
CAMBRIDGE, MASS.

CYTOPLASMIC INHERITANCE OF MALE STERILITY IN ZEA MAYS

WHEN the transmission of a character has been conclusively proved to be independent of nuclear factors it must necessarily be inherited through the cytoplasm. Such a mode of inheritance is called cytoplasmic in contrast to the better understood Mendelian inheritance. The few cases of cytoplasmic inheritance that have been clearly established are concerned with certain chlorophyll characters in plants in which the nature of the cytoplasm or plastids contributed by the maternal parent or, more rarely, by either parent, determines whether the progeny shall be green or abnormal (white, pale green, or variegated). There is at least one case (in flax) where the interaction of specific genes with the cytoplasm of one of the parental types results in male sterility; this can not be considered as purely cytoplasmic inheritance, since nuclear factors are also involved.

Recently, investigations of the inheritance of a male sterile line of maize found in a collection made by R. A. Emerson and F. D. Richey at Arequipa, Peru, indicate that the sterility is determined entirely by the non-nuclear elements of the maternal gamete. The cross of the original male sterile plant by an unrelated normal gave an F_1 of 45 sterile individuals. The F_2 cultures consisted of families which bred true for male sterility, and of others that gave normal-appearing individuals in addition to sterile plants. Races in later generations have been established which (1) breed true for male sterility, (2) throw male sterile and normal plants, and rarely (3) are completely normal. There is no female sterility apparent.

The analyses made permit the following statements concerning the inheritance of the male sterile character:

1. Replacement of the original chromosomes in the

male-sterile line with chromosomes from normal lines has no effect on the sterility. Through the use of Mendelian markers (genes) it was possible to show that 9 of the 10 linkage groups were free from any factor or factors causing the sterility. Tests are incomplete for the tenth group.

2. Pollen from partially sterile plants carry no transmissible factors, either genic or cytoplasmic, for male-sterility.

3. The genetic constitution of the male parent crossed with a male sterile individual has no demonstrable effect on the degree of sterility.

4. Cytological investigation shows the meiotic divisions in microsporogenesis to be normal. The degeneration of the pollen occurs usually after the first vegetative division.

Marcus M. Rhoades

Cornell University

TREES WITH TWISTED BARK

In Science for February 13 there is an article[1] by Mr. C. K. Wentworth on "Twist in the Grain of Coniferous Trees." Mr. Wentworth points out that the bark of conifers often shows a decided twist, and that in the cases of several hundred trees which he has examined the twist is usually right-handed. He adds that he has not noticed any similar twist in deciduous trees, but supposes it may perhaps occur.

These statements have recalled to me a twist which I noticed some years ago in the barks of maples and elms. I supposed that if the effect were at all common it was probably well known to botanists. However inquiry from two botanists did not indicate that either of them happened to know of it, and in connection with Mr. Wentworth's paper I am venturing to report my observations.

The number of trees which I have observed is small, and all of them are in the city of Northampton, Massachusetts. The maples often show a rather pronounced twist in the bark, and this twist seems to be almost always right-handed. On elms a twisted bark seems to occur less frequently, but when it does occur it is usually left-handed. In one location there are two large elms with strong left-handed twist growing near to a large maple that has a strong right-handed twist.

The number of trees which I have observed is too small to permit of drawing any general conclusions, but in this small number the twist seems to be more frequent in maples than in elms, and seems to be usually right-handed in maples and left-handed in elms.

Arthur Taber Jones

Smith College

[1] Chester K. Wentworth, Science, 73, 192, 1931.

PANAMAN OR PANAMANIAN?

In numerous journals, including Science, and in the press, the use of the adjectival form, Panamanian, has been noted. The proper noun, Panama, does not seem to differ in any essential way from the many other proper names, geographic and personal, which end in "a."

The well-nigh universal practice in forming the adjective from such nouns is the simple addition of a final "n." Thus African and American instead of Africanian and Americanian. Other common examples of such words are: Alabama, Atlanta, Asia, Australia, California, Caligula, Dominica, Florida, Guatemala, Inca, Iowa, Korea, Maya, Montana, Nebraska, Nicaragua, Olympia, Peoria, Persia, Polynesia, Russia, Seneca, Utica, Utopia, and Volga, and most of the rest of the long roll. For these we write, in the adjective form, Albertan, Incan, Mayan, Nebraskan, Polynesian, Utican, etc., but never the double suffix, as Iowanian, Mayanian or Nebraskanian. Therefore, why Panamanian instead of Panaman?

There are some exceptions to the general rule, of course. It would not be our English language if there were not. Canada becomes Canad*i*an and Carolina is transformed to Carolin*i*an, probably partly from ideas as to euphony and partly from resemblance to those adjectives formed by adding "n" to a final "ia," as, Asia: Asian. But, even so, one never sees Canadanian or Carolinanian, which are exact counter-parts of Panamanian.

Another exception is China, although there is nothing wrong with Chinan except its unaccustomedness —and one never meets with Chinanian. Let us make it unanimous for Panaman!

Carleton R. Ball

University of California

ESTRUS

There has been recently some discussion in your columns on the right use of Greek and Latin case endings in scientific nomenclature. May I draw to your attention the misuse of the word "Estrus" which has crept into the literature. This word was introduced by Heape to denote the period of sexual desire in the female and was correctly spelt by him "Œstrus," but many writers prefer the form "Estrum." It is inconceivable that the gadfly which chased the sprightly heifer, Io, into Egypt could have been anything but masculine, so this form must be, not the neuter gender but the accusative case, which is undefendable. The adjectival form "estrous" is often badly distorted too. The modifications "postestrum," "metestrum," "diestrum" and "anestrum" are

naturally correct, being the accusative cases after the prepositions.

In regard to the perversion of the initial diphthong, I have nothing to say; that is usually the result of editorial pressure and it is far from my desire to kick against the pricks.

S. A. ASDELL

LABORATORY OF ANIMAL NUTRITION,
N. Y. STATE COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY

AN APOLOGETIC CORRECTION

IT has come to my attention that I have, on the basis of insufficient information, done an injustice to the memory of George Compere in my recently published "History of Applied Entomology." In that book I have indicated that George Compere was responsible for the introduction and establishment in California, under the impression that it was a primary enemy of the black scale, of a secondary parasite (now known as *Quaylca whittieri*) which has destroyed very largely a very important primary parasite of the scale.

Mr. Harold Compere, son of the late George Compere, himself an advanced student of parasites and a thoroughly sound scientific worker, has access to the correspondence of his late father and has found in this correspondence a distinct warning sent by George Compere to Alexander Craw (at that time in charge of the California state introductions of parasites) to the effect that this particular parasite might be a secondary and that he should be very careful about it.

This particular parasite belongs to the subfamily Encyrtinae, and at that time I knew no hyperparasite belonging to that group. Mr. Craw sent specimens to Washington for naming and for advice. I sent him a manuscript name given to it by the late Dr. W. H. Ashmead and told him that I knew of no hyperparasites of this group. This would seem to place the onus on me, and would do so were it not for the fact that I was in the habit of visiting California each year and had repeatedly talked with Mr. Craw on the subject of these parasites, warning him again and again not to liberate anything without making careful life history studies in the little quasi laboratory that he had fitted up in his office near the ferry building in San Francisco.

I gladly publish this statement, since George Compere was at one time a friend of mine and since I have the highest admiration and regard for his able son.

L. O. HOWARD

WASHINGTON, D. C.

SCIENTIFIC BOOKS

La Parthénogenèse. By A. VANDEL. Vol. 7 of Bibliothèque de Biologie Générale. Paris; Gaston Doin et Cie., 1931, 412 pp., 42 figures in text. Price 32 francs.

IT is a matter of surprise that prior to Professor Vandel's publication no thorough review of the subject of natural parthenogenesis had appeared, despite the prevailing tendency to summarize and digest the subject-matter of the different branches of biology. It is true that in 1920 Winkler collected a very large amount of the available findings in this field, but, aside from using it in weighing Ernst's hypothesis of hybridization as a cause of apogamy among plants, he made little use of this gathering of information. Vandel's book is therefore the first to give an adequate treatment of a subject, the extent and difficulty of which are attested by the 700 odd titles in the bibliography (which lists publications up to and including 1929). In accomplishing his task, Vandel takes up the subject under a number of wisely chosen headings. The treatment of the field observations and the breeding work under these headings is followed by a critical examination of the cytological findings, and this in turn is succeeded by a consideration of the possible points of contact with artificial parthenogenesis and a discussion of the question of sex determination. Throughout, Vandel gives a concise and clear exposition of the questions at issue and I am in sympathy with his unexpressed view that in the present state of the subject it is always preferable to broach an hypothesis rather than to leave a question entirely open. If his wholly admirable suggestions are interspersed with a few that will hardly stand up under a strict test, it must be said that all are advanced with a commendable caution. Vandel's firm and well-founded insistence that haploid and diploid parthenogenesis are basically unrelated I can only applaud.

The book has few faults. The cytological illustrations are often inadequate, but this criticism applies more to their reproduction than to their selection. The fact that the bibliography is given under chapter headings instead of being presented in one continuous alphabetical list is not without its disadvantages, although the numbering of the titles is of some aid in locating references.

It is with pleasure that I commend this work, which, far from betraying the drudgery which must have accompanied its preparation, is written with spirit and brightness.

FRANZ SCHRADER

DEPARTMENT OF ZOOLOGY,
COLUMBIA UNIVERSITY

Star Clusters (Harvard Observatory Monographs No. 2). By HARLOW SHAPLEY. xi + 276 pp. McGraw-Hill Book Company, New York, 1930. $3.00.

ONE of the reasons why many star clusters are worth studying is that they present stars of different physical characteristics at practically the same distance. The possibilities here offered have been utilized with startling success.

"Star Clusters" tells the story of the exploration of this interesting field of modern astronomical activity. The author of the book has had a lion's share in the advancement of the subject. The fifteen years of active study of star clusters have not lessened his enthusiasm for the subject, as is apparent from every page of the book.

The book deals with galactic and globular clusters but with the latter in the forefront. It does not pretend to give an exhaustive treatment of all the ground it covers but contains abundant references to subjects treated elsewhere. As part of its plan, and a very welcome part to its readers, it presents as one unit Professor Shapley's own researches, published in numerous papers, now extended and amended where necessary.

The author states in his preface that he has postponed the publication of this monograph till a revised system of parallaxes for globular clusters could be available. It is evident how much time-consuming labor members of the Harvard Observatory Staff, under Professor Shapley's direction, had to accomplish in order to provide for the finishing touch to many chapters.

The period luminosity curve for Cepheid variables is newly derived from a richer material of variables in the Small Magellanic Cloud only.

Theoretical considerations in connection with the period-luminosity relation are presented in two separate paragraphs (22 and 51). It is to be regretted that the subject has not been treated as a whole.

Paragraph 44 gives some historical notes in connection with the period luminosity relation. Hertzsprung is given credit for his early work on Cepheid variables. But the interesting fact that he was the first to use the relation for the determination of the distance of the small Magellanic Cloud is not stated. In the same paragraph, when reference is made to "some vigorous critical discussion of the data on galactic Cepheids," Dr. Schilt's contributions are not mentioned.

In recent years much has been written about the transparency of space. An interesting chapter is devoted to this subject of intrinsic importance when one deals with the huge distances of globular clusters and extra-galactic nebulae.

In a chapter, "Data Bearing on the Origin of the Galaxy," the knowledge of star clusters is used as a basis for an interesting tentative discussion of the galactic system as a unit of higher order in the universe.

Forty-six pages at the end of the book are devoted to four valuable appendices. They give catalogues of globular and galactic clusters and a very complete bibliography of star clusters containing 812 titles.

It may be a decided disadvantage when the author's own researches have covered practically the whole subject treated in a book. His presentation will almost necessarily be too subjective. In this book we frequently notice such a lack of objectiveness when important contributions of others are reviewed in a few words. This is especially regrettable if, on this account, work of original character does not receive proper emphasis.

DIRK BROUWER

YALE UNIVERSITY OBSERVATORY,
FEBRUARY 13, 1931

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A DEVICE FOR WASHING TISSUES

IN our laboratory it became necessary to devise an apparatus for washing fixed tissues in running water. It was desirable to arrange this apparatus to accommodate the material of a technique class of about a half-dozen students so that all individuals could use it without interfering with each other's material or hampering the efficiency of the apparatus.

The apparatus is so constructed that any one who is handy with a pair of tin shears and a soldering iron can put it up in an hour's time from a few scraps of thin galvanized iron at no cost whatever.

Essentially the apparatus consists of a tank (K), a rack (E) to hold the tubes containing the material and an overhead trough (C) to distribute the water. Fig. 1 shows the apparatus as it appears when assembled. It is set up from only three parts that need to be cut to pattern and two small tubes. The pattern of the tank itself is shown in Fig. 4. Dotted lines indicate folds in the metal. The nature of such folding will be apparent at once by reference to Fig. 1. The holes at A are to take screws to support the whole apparatus on the under side of a shelf above the laboratory sink. The hole (S) shown in Fig. 4 (not visible in Fig. 1) is a drain, but kept closed with a cork when the apparatus is in use. The overflow pipe (L, Fig. 1) is soldered over the hole L (Fig. 4) and the inflow pipe (M, Fig. 1) is soldered over the hole M (Fig. 4). These pipes are easily fashioned from small rectangular pieces of the sheet

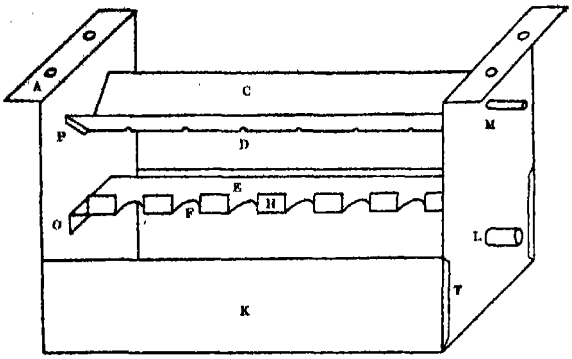


Fig. 1

metal by using round objects such as bolts, etc., to hammer the metal around. Overlapping joints (T) are soldered to the upright ends of the tank so that the joints are water-tight.

The pattern of the rack is shown in Fig. 2. Its nature is apparent when reference is made to Fig. 1. The slots (F) are made by drilling the metal first with round holes of appropriate size and properly spaced. In our apparatus these holes were made

Fig. 2.

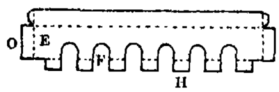
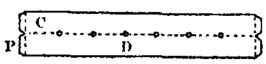


Fig. 3.



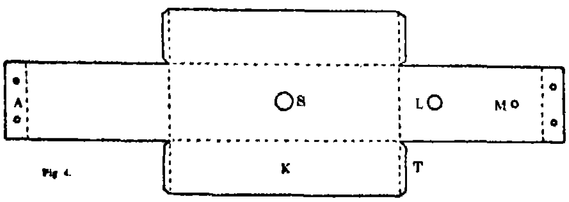


Fig. 4.

$\frac{3}{4}$ inch in diameter. After the holes are drilled they are cut into slots by the tin shears. The projecting ends (H) are then turned up as guards (Fig. 1). The part above the upper dotted line (Fig. 2) is bent at a right angle to the rest (E) and forms a strengthening flange not visible in Fig. 1. The ends (O) are turned and soldered down to the ends of the tank as shown in Fig. 1.

The construction of the water-distributing trough is simple (pattern in Fig. 3). It is merely a V-shaped trough (C, Fig. 1) with nail holes (D) punched in its bottom in such a manner that they will be properly centered over the slots (F) in the rack. The ends (P), as in the case of those of the rack, are turned over and soldered down to the ends of the tank.

The outlet pipe (L) is set so that the top side of it is about $\frac{1}{4}$ inch below the top of the side (K) of the tank and it is sufficiently large to be a positive drain. The inlet pipe (M) may be much smaller.

As stated before, our apparatus is fastened on the under side of a shelf over the laboratory sink. Water is supplied through a rubber tube slipped over the pipe M. In order for the apparatus not to interfere, even when in constant use, with ordinary use of the water faucet at the sink we had our college engineer set an $\frac{1}{8}$ inch petcock permanently into the faucet back of its valve.

Ordinary $\frac{3}{4}$ inch flanged test tubes make excellent tissue holders. These are cut off about 2 to $2\frac{1}{2}$ inches below the flange, or short enough to clear the bottom of the tank and permit a free flow of water through them. These cut ends are closed with silk or with bolting cloth. These tubes containing the tissues are suspended in the slots in the rack. The water is started and allowed to flow into the trough. It drips through the holes (D) into the tubes suspended in the slots, fills the tank and overflows through the outlet tube (L). The overflow may be allowed to fall directly into the sink or it may be carried to any desired point with a large rubber tube.

The tissue-containing tubes are constantly suspended in water even should the flow be stopped. While the water is flowing clean water constantly passes the tissues. The rate of flow may be regulated by the petcock.

Such an apparatus as this may be made of any suitable size. More or less slots may be made according to the number of students using the apparatus or the amounts of tissues being washed. Our apparatus measures $10\frac{3}{4}$ inches in length and has six $\frac{3}{4}$ inch slots. These slots may, however, be made to accommodate any size of tube.

C. T. Hurst

Western State College of Colorado

A MACHINE FOR PULLING GLASS MICRO-PIPETTES AND NEEDLES

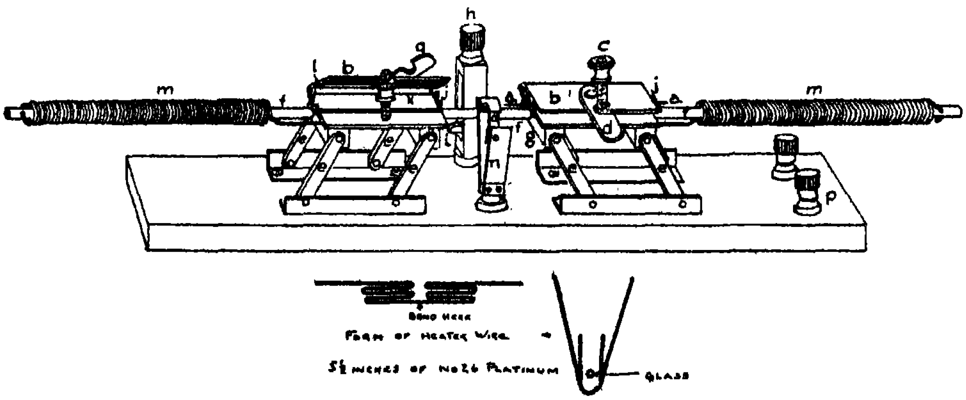
In designing a machine for this work a study was first made of the hand movements of an expert in making needles and pipettes. The essential movements seemed to be a removal of the glass from the heater at the correct temperature followed by a rather quick horizontal pull-out.

In the machine as designed a parallel motion was devised which, when the glass becomes plastic enough to stretch under a light pull, lifts the glass up and out of the heater, and, at the same time, increases the pull by an increase of leverage. The result is a rapid pull-out at the correct instant.

The machine as shown in the diagram is in its final

position after pulling two needles, and one needle (a) is still held in the machine by the clamp (b) though the locking nut (c) has been unscrewed (much more than is necessary to release the latch (d)). It is obvious from the drawing that the clamps (b) remain always parallel to the base due to the hinged side bars (e) but perhaps it is not so clear that the alignment rod (f) passes with a sliding fit through the cross-bars (g) of the clamps (b) so that the two clamps must move up and down together, always remaining in alignment with each other. To "set" the machine the clamps are pressed down until, by turning the knurled knob (h), the retaining bar (i) may be swung over the alignment rod (f). The clamps are then opened and a glass rod or capillary of double length is dropped between the guides (j). This rod or capillary will rest on the leather pads (k) and when the clamps are closed and latched will be held firmly by the rubber pads (l). The retaining bar (i) softened and so controls the length of the tapering shank of the point. With the form shown this will be about correct, but the shank can be lengthened by spreading the loops of the wire if desirable. The temperature of the heater depends upon the current which flows and this can be adjusted by the series resistance to give a safe temperature which will not burn out the platinum. At this temperature, the color of the wire is a bright yellow. A current of 7½ amperes may be used for No. 26 platinum wire.

The heater is adjustable in position and should be set squarely under the glass rod. The heater can be raised and lowered and the loops may be bent in and out. If the heater is too low or too open at the top of the loops the heat will not be maintained long enough as the glass rises, and the final taper may be too short or the tip broken. On the other hand if the heater is too high the final taper will be too long or the tip fused.



may now be swung off, without changing the position of the machine, though the glass will now be under the tension of the springs (m). In this position the glass rod or capillary will pass through the heater (n) and upon switching on the current the glass will become softened. It will pull out, first slowly and then, as the clamps rise, the action will become rapid, ending with a quick pull-out, and two needles or pipettes will be pointed and ready for bending.

This machine has a number of elements which can be adjusted to give any form of needle or pipette point desired. This is necessary as different types of points are often required, but no change in adjustment is necessary for glass of different diameters.

The heating element is a platinum wire in a V-shaped holder of mica. A resistance must be used in series with the heater with a snap switch to turn on and off. If the platinum wire is too small it may burn out. At least size No. 26 should be used. The best form of the wire is shown in the diagram. The width of the heater determines the length of glass

One other adjustment that can be made is the position, up and down, of the bar that locks the machine while the glass is being clamped in place. The lower this bar is adjusted the less will be the initial tension on the glass. It should be kept fairly low.

It will be seen that each of these adjustments affects the others. Thus an increase of heater current or a raising of the heater, or a lowering of the locking bar will all act to increase the heat delivered to the glass. The main thing seems to be a rather intense heat at the start, maintained as the glass rises until just before the pull-out. The exact setting, however, can only be made experimentally.

With the machine adjusted to give the type of point desired, it is possible to turn out pipettes or needles at the rate of four to six per minute. This machine is now in use in Dr. Chambers' laboratories.

DELAFIELD DU BOIS
LABORATORY OF CELLULAR BIOLOGY,
WASHINGTON SQUARE COLLEGE,
NEW YORK UNIVERSITY

SPECIAL ARTICLES

BRAIN WATER MOVEMENT DURING ANESTHESIA

ALTHOUGH dehydration has for nearly half a century[1] been considered a probable accompaniment of anesthesia, apparently direct confirmation of this fact on nerve cells has never been reported. Suggestive analogies, however, have been brought forward in connection with the narcosis of plants. Furthermore Knaffl-Lenz[2] has shown that the swelling of red blood cells in hypertonic saline solutions is prevented by low concentrations of alcohol. He confirmed this with other anesthetics which also dehydrated gelatin plates. Similarly, Kochmann[3] inhibited the acid swelling of fibrin particles by anesthetics. This investigator further found the narcosis of frogs' gastrocnemii by chloroform, chloral and a series of alcohols accompanied in each case by reversible dehydration.

The water content of nerve centers is difficult of investigation, owing to the fact that each determination must be made on a new individual, and statistical data built up for the particular age and conditions of the animals. Apparently this type of investigation has hitherto been attempted only by Haldi[4] who, with Larkin and Wright, obtained results indicating that various anesthetics differ among themselves as to their effect upon the water content of the brain as a whole and of certain subdivisions. Both ether and morphine in three- or four-hour experiments on rabbits increased rather than decreased the water content of the various parts of the brain.

Brain hydration was found on withdrawal of morphine from young adult rats and dogs by Flowers and Dunham[5] working with the writer; this led to an attempt to learn more of the relations of brain water to narcosis. In our first experiments when a single dose of morphine was given to rats, the cerebrum was found somewhat dehydrated after two hours. A year ago, Dunham, Ellerbrook and I, in confirming this fact, showed that several hours after morphine injection the dehydration occurred both in cerebrum and medulla; but *during the first two hours* a marked difference was noted in that while the cerebrum usually lost water, the primary effect upon the medulla was *hydration*. Thus we have in early morphine narcosis a condition in which the ratio medulla H_2O/cerebrum H_2O is markedly increased.

[1] V. E. Henderson, *Physiol. Rev.*, 10: 176, 1930.

[2] E. von Knaffl-Lenz, Pflüger's Arch. Physiol., 171: 51, 1918.

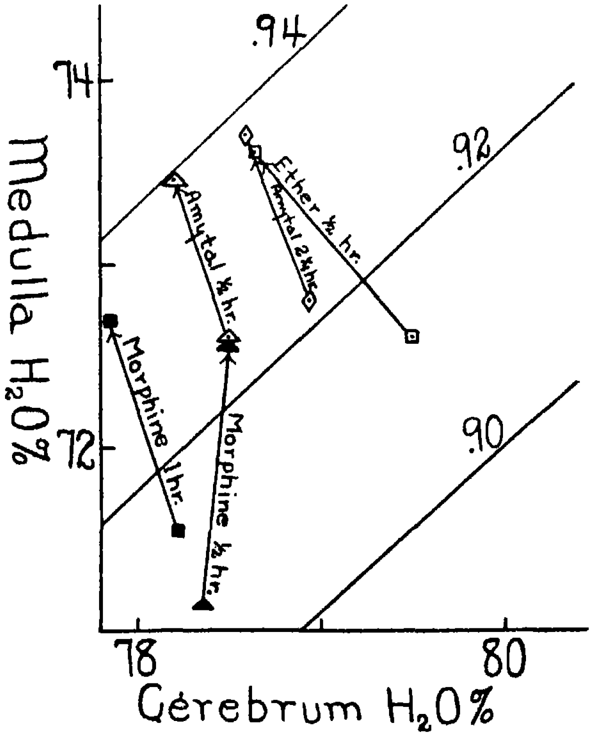
[3] M. Kochmann, *Biochem. Zeitsch.*, 136: 49, 1923.

[4] J. Haldi, J. Larkin and P. Wright, *Amer. J. Physiol.*, 88: 112, 1929.

[5] S. H. Flowers, E. S. Dunham and H. G. Barbour, Proc. Soc. Exper. Biol. and Med., 26: 572, 1929. H. G. Barbour, B. E. Russell, S. H. Flowers, E. S. Dunham and L. G. Hunter, *Amer. J. Physiol.*, 90: 273, 1929.

The use of the medulla H_2O/cerebrum H_2O ratio tends to minimize individual variations between animals. For example, one rat as a whole might be wetter than another without a change in this ratio. When it does change a possible shift of water from one part of the brain to another is thereby suggested.

Recently Flowers and I have extended the anesthetic work to include amytal and ether, and have confirmed the increase in the medulla H_2O/cerebrum H_2O ratio in rats, and in the case of ether in young rabbits as well. While this ratio is normally around .92, it may rise to nearly .94 in early anesthesia, as shown by the diagonals in the accompanying figure.



The medulla water percentage is plotted as ordinate against the cerebrum water percentage as abscissa, and the dehydration of the cerebrum shown in four out of five cases is quite overshadowed by the hydration of the medulla.

While all the anesthetics mentioned tend to increase the general muscle tone of rats, a true "stage of excitement" occurs only after ether. In the above-mentioned experiments it was brief. Ether excitement intentionally prolonged for half an hour in one rat and two rabbits produced no significant increase in the medulla H_2O/cerebrum H_2O ratio. Furthermore, one half hour muscular activity in an unanesthetized rat gave only a normal figure. Hence the water shift described appears directly associated with the process of *narcosis*, not with preliminary stimulation of any sort.

The results are summarized in the following table where fifteen control rats are seen to have given an average medulla H_2O/cerebrum H_2O ratio of .922 ± .003, while thirteen morphinized rats gave an average ratio of .939 ± .007.

TABLE

Condition	Duration	Average Medulla H_2O / Cerebrum H_2O Rats (No.)	Rabbits (No.)
Anesthesia:			
Morphine sulfate	½–2½ hrs.	(13) .939 ± .007*	
Amytal	½–2½ hrs.	(5) .931	
Ether	½ hr.	(1) .936	(2) .933
Excitement:			
Ether	½ hr.	(1) .928	(2) .920
Muscular activity	½ hr.	(1) .924	
Controls (normal)		(15) .922 ± .003*	(3) .926

* Standard deviation of the average.

The above findings (which we plan to report more completely in *The American Journal of Physiology*) are entirely consistent with the conception that anesthesia in mammals is associated with the dehydration of nerve cell bodies. It is conceivable that early in narcosis the colloidal condition of the cells is altered in such a way as to extrude water (*cf.* Claude Bernard's semi-coagulation theory[6] or Hirschfelder's[7] demonstration of lessened lipoid dispersion).

Dehydration of the cerebrum is the rule, at least in rats. The extra water taken on by the medulla not only may be located entirely outside of the nerve cells but may even be derived from the nerve cells of both medulla and cerebrum. The interfibrillar spaces may well serve as a temporary storehouse for water during readjustments of brain pressure and the like. At all events our results indicate that the first accompaniment of brain narcosis is a temporary storage of water in the medulla, partly at the expense of the cerebrum.

H. G. BARBOUR

UNIVERSITY OF LOUISVILLE

METALLIZED FOOD IN THE REGENERATION OF HEMOGLOBIN IN RAT AND MAN

To eliminate the acidity of salt solutions used in the regeneration of hemoglobin in animals made anemic by deficient diets, Fe, Co, Mn and Cu were dissolved directly in milk while in the ice box.[1,2,3] After 12 hours half the milk was used after being shaken, and the balance was shaken and used 12 hours later. The metals were washed and placed in fresh milk for the next day and so on. In this way enough of the metals dissolve in milk to supply the requirements for rapid hemoglobin regeneration in rat and man, as seen below.

On April 22, 1929, two dozen young white rats, reduced to 75 per cent. hemoglobin by feeding on pure raw milk, were equally divided in two identical cages, A and B, Fig. 1, and each rat was then fed

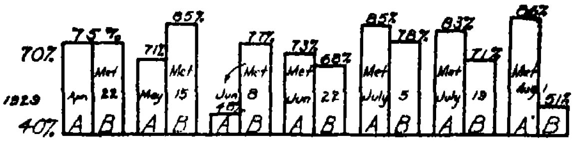


FIG. 1

50 cc of raw milk per day, free from metallic contact in its production and storage.[4] Into the 600 cc of milk for group B 181 gms of Fe, Co, Mn and Cu in alloy form were placed each day for the two feedings. A was the first and B the latter control. All hemoglobin is reported in percentage (Newcomer). The second and third graphs of Fig. 1 show the percentage *differences* after three and six weeks, being respectively 14 per cent. and 29 per cent. on May 15 and June 8. On June 8 the alloys were transferred from the milk for B to that for A. In 14 days group A average hemoglobin had risen from 48 per cent. to 73 per cent., while that of B had fallen from 77 per cent. to 68 per cent. as per the fourth graph. Progressive, average percentage differences increased as seen in the fifth, sixth and last graphs, when on August 1, 6 per cent. beyond a complete reversal appeared in average per cent. hemoglobin of the two groups. Tangents drawn to A and B of the third group and to B and A of the last group meet almost at right angles. Note that B on May 15 equals A on August 1, both with metals. Group B shows evidence of some metal retention by a very gradual decline in hemoglobin during 8 weeks. Fig. 1 shows remarkable hemoglobin control by a metallized diet.

In order to compare the hemoglobin regenerative effects of direct metallization with salt effects, the tests of Fig. 2 were made. The average hemoglobin of the rats studied in the 7 cages of Fig. 2 had dropped on a pure milk diet to 38 per cent., and all

6 The current work of Bancroft and Richter (Proc. Nat. Acad. Sci., 16: 573, 1930., and *J. Phys. Chem.*, January, 1931) contributes striking evidence that narcotics produce a reversible semi-coagulation.

7 A. D. Hirschfelder, *J. Pharmacol. and Exper. Therap.*, 37: 399, 1929.

1 Clarice M. Burns, *Biochem. Jnl.*, 32: 5, 860.

2 Elvehjem and Hart, *J. Biolog. Chem.*, 84: 131, 1929.

3 Waddell and Steenbock, *J. Biolog. Chem.*, 84: 115, 1929.

4 Lewis, Weischelbaum and McGhee, *Proc. Soc. Exp. Biol. and Med.*, 27: 329, 1930.

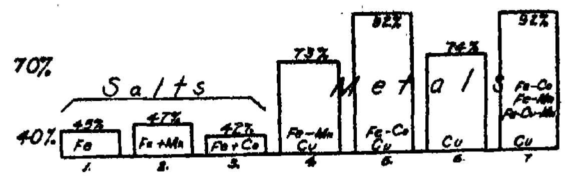


FIG. 2

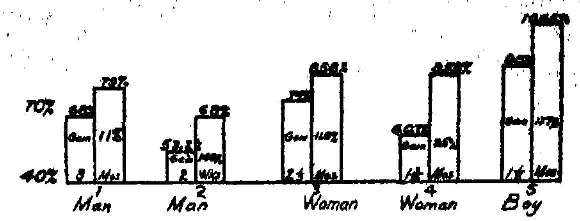


FIG. 3

were remarkably close to the horizontal line in the figure, when, on July 23, 1929, the indicated salts were added to the milk of the first three and the noted metals to the other groups, in weights seen in the table. The average rise in hemoglobin per cent. in each cage of 6 or 8 rats during 7 weeks is seen in the 7 graphs. Graph 6 shows effects of pure Cu only.

The rats in cage 7 were comatose and all below 38 per cent. hemoglobin with little appetite before the metals were put into their milk diet. After 4 days on metallized milk they were playing and ate ravenously, rising in eight weeks from below 38 per cent. hemoglobin to 92 per cent.

THE WEIGHTS OF SALTS FED PER RAT PER DAY IN FIG. 2

Cage	No. 1	No. 2	No. 3
	0.5 mg Fe as $FeCl_3$	0.1 mg Fe, 0.1 " Mn as chloride	0.1 mg Fe, 0.1 " Co as chloride

THE WEIGHTS OF COPPER AND ALLOYS PER RAT PER DAY IN FIG. 2

Cage	No. 4	No. 5	No. 6	No. 7
	Fe–Mn, 3.24; Copper, 0.31 mgs	Fe–Co, 0.135; Copper, .306 mgs	Copper .306 mgs	Fe–Co, 0.16; Fe–Mn, 3.04; Fe–Mn–Cu, .384 Copper, 0.27 mgs

These weights are cage averages. The sheet Cu is free from Fe, Al, Mg, Ni, Zn, Li, and has only traces of Co and Mn, respectively 10 parts and 1 part per million.

Copper alone is quite effective, but more so with other metals, suggesting that mutual influences probably exist when several metals function together, which may fail when they are separate.

After using metallized milk himself for eight months to determine possible pathological results, the writer secured the cooperation of physicians and executives in three local cotton mills and tests were made of the effects of metallized milk on a number of employees who had secondary anemia. Each person was examined after using a directed diet for two weeks including sweet milk, the percentage of hemoglobin being specially noted. Results typical of 50 cases are shown in Fig. 3, with a record of the hemoglobin percentage gain of each and the time involved.

The ages of the two men, two women and one boy, in order, are 59, 28, 49, 28 and 16 years. No change in color, odor or taste occurs if the immersed metals are pure. The man of graph 2, Fig. 3, ingested 0.5 mg of copper per day, and approximately 0.7 mg of iron. Tests of the duration of these effects are being made.

CONCLUSIONS

(1) Metals dissolve enough in milk to supply the requirements for rapid regeneration of hemoglobin in rat and man.

(2) Copper alone is effective but less so than when accompanied by other metals, especially iron.

(2) Much less mortality occurs among rats fed on metallized milk than when salts of the metals are used in anemia tests.

(4) These metals produce no odor, color, taste or other observed change in milk with the quantities used unless they are exposed to air and milk.

J. L. MCGHEE

EMORY UNIVERSITY

BOOKS RECEIVED

ALLEE, W. C. *Animal Aggregations.* Pp. ix + 431. 35 figures. University of Chicago Press. $5.00.

BRIDGES, T. C., and H. H. TILTMAN. *Master Minds of Modern Science.* Pp. 278. 32 illustrations. Dial Press. $3.00.

HATCH, F. H. *An Introduction to the Study of Ore Deposits.* Pp. 117. 31 figures. University of Chicago Press. $2.50.

HAWKS, ELLISON. *The Book of Electrical Wonders.* Pp. 316. 40 plates and 91 figures. Dial Press. $3.00.

Kyoto Imperial University. *Memoirs of the College of Science.* Series A. Volume XIV. No. 1. Pp. 42. Maruzen Company, Tokyo.

PIERCE, FREDERICK. *Dreams and Personality:* A Study of Our Dual Lives. Pp. xii + 337. Appleton. $3.00.

SMART, HAROLD R. *The Logic of Science.* Pp. vii + 237. Appleton. $2.50.

VON BERNEWITZ, M. W. *Handbook for Prospectors.* Second edition. Pp. xi + 359. 89 figures. McGraw-Hill. $3.00.

WHITNEY, JESSAMINE S., Editor. *Facts and Figures about Tuberculosis.* Pp. 63. National Tuberculosis Association, New York, N. Y. $.75.

SCIENCE

VOL. 73 FRIDAY, APRIL 3, 1931 No. 1892

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

IS AN INTERNATIONAL ZOOLOGICAL NOMENCLATURE PRACTICABLE?[1]

By Dr. C. W. STILES

MEMBER OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

AFTER an experience of about forty years in an attempt to standardize a code of international rules to govern zoological nomenclature, it will be well for zoologists to consider briefly the outstanding difficulties which at one time or another have inhibited the degree of success which it was hoped would attend the undertaking. Possibly a short review of the subject will indicate whether or not it is worth while to continue the effort.

At the First International Zoological Congress (Paris, 1889) R. Blanchard presented a proposed code of international rules, prepared by himself, after careful consideration of the world's literature on the subject, and naturally he was influenced to no slight degree by the existing French rules. This draft was discussed by the First and Second Congresses (Paris, 1889, and Moscow, 1892) and was formally adopted.

In 1894, the Deutsche Zoologische Gesellschaft adopted an independent code, thereby (at least inferentially) declining adherence to the international code.

In 1895, F. E. Schulze (Berlin, Germany) raised the point at the Third Congress (Leyden), that the Paris-Moscow code was essentially a French production, and he proposed the appointment of an international commission to study all the existing rules with a view to obtaining a really international code.

This proposition produced considerable bitter feeling which threatened to send the Third Congress on the rocks. Oil was poured on the troubled waters,

[1] Presented before the Biological Society of Washington, December 13, 1930.

however, and a commission of five men, representing five different countries (four Old World, one New World), was appointed.

This commission worked hard for three years and attended the Fourth Congress (Cambridge, England, 1898), prepared to present its report. Unfortunately, but not unnaturally, this report was not unanimous in all details, and as a result it was referred back to the commission (which was then enlarged to fifteen members) for further study. In fact, the British administrative office of the congress declined to permit the report to be read, giving as reason the fact that the report was not unanimous.

Thus, Great Britain's administrative representative *insisted upon the principle that international rules* of nomenclature are not to be made subject to a majority report or a majority vote, but must be based on a unanimous agreement in commission.

Three years later, the commission appeared at the Fifth Congress (Berlin, Germany, 1901) with a more nearly unanimous but not absolutely unanimous report, and was given unambiguously to understand that the congress would not permit its general sessions to be turned into an open forum for the discussion of differences of opinion on rules of nomenclature and that unless the commission could present a *unanimous* report it would not be given a hearing before the general session. Thus the German presiding officer of the congress confirmed the principle insisted upon by the British office. Conferences were held between various members of the commission and various other zoologists. As what promised to be a permanent policy seemed to be formed, and as Germany had been the initiating factor in the appointment of the commission, it seemed logical to attach considerable importance to the reaction of the Deutsche Zoologische Gesellschaft. Accordingly, two foreign (French, American) representatives on the commission conferred with an officer of the Gesellschaft, explained to him some of the difficulties which the commission faced, and asked in how far the commission could rely upon the support of the Gesellschaft in case the commission could, by mutual concessions on various points, iron out some of the differences of opinion, even if the result were not generally popular. The reply was to the effect that the commission could rely absolutely upon the Gesellschaft to support it in the final results. This was confirmed by the three German representatives on the commission.

> As one prominent German member of the congress [an officer of the German Zoological Society] stated *in effect:* "It is the duty of the commission to become unanimous in its vote; give us a definite set of rules, good, bad, or indifferent, but be unanimous in your report, and after you give us the rules, see that they are carried out." The words of this prominent German savant were a fair reflection of the feeling we found at the Berlin meeting, so far as the secretary of the commission could discover.[3]

Further concessions were made and finally the commission was permitted to present a brief report to the General Session and the motion prevailed that the congress approve those portions of the report on which the commission was unanimous.

This general incident on *unanimity* is what has been known in the commission as the "Berlin Agreement." It has been accepted as a "gentlemen's agreement" to which the commission has rigidly adhered.

As a corollary to this gentlemen's agreement (requiring unanimous vote in commission preceding the adoption of the rules) follows the parliamentary principle that amendments are subject to the same system or by-laws as the original motion. This principle was definitely incorporated in the by-laws of the commission. Thus, *according to parliamentary* usage and to the by-laws of the commission, amendments to the original (1901) rules require a unanimous vote in commission.

At the Sixth Congress (Berne, 1904), some slight criticism of the Berlin report developed; this took the form that portions of the report were not entirely clear. These criticisms, emanating from Berlin, did not come to discussion in congress but only in the commission, in which friendly difference of interpretation existed in reference to one article in particular (a point which was made unambiguous at a later Congress). The code was then issued (1905) in French, English and German.

Shortly after the Berne (1904) Congress, there appeared in Germany a new proposition, by a Berlin *zoologist, for a total revision of the wording of the* code.

It is a recognized fact that courts exist not only for enforcing laws but also for interpreting laws and for settling controversies: "Interest rei publicae ut sit finis litium." The commission has no power to enforce the rules, but at the Seventh (1907) Congress, at Boston, the custom was introduced of issuing commission opinions, in the hope of contributing toward the solution of difficulties and (in case of difference of interpretation) of showing what the commission understood that the rules meant (thus "interpreting" the rules).

Zoologists in the United States, who had been very slow in accepting the international rules and many of whom had for years been working chiefly under the "A. O. U. Rules," now became gradually per-

[3] Report of the International Commission to the Congress, IX[e] Congrès int. Zool., Tenu à Monaco, 1913. Published 1914.

suaded that the "Berlin Agreement" was an established factor, that the rules were stable as they stood although they might be built out in various directions to meet new points. As a result, these zoologists rapidly gravitated toward the international rules. In the United States, up to this time, there had been misgivings lest the triennial congresses might adopt, by popular vote, some reactionary rule or policy. But, by 1907, the policy seemed to be generally accepted that a special commission on nomenclature was to guide the subject in the future, and that international unanimity, not local majority, agreement, not dissension, leading, not driving, true international cooperation, not local individualism, friendly discussion, not personal polemic, were to be the determining factors in the future.

In 1910, at the Eighth Congress (Gratz), dissension appeared from Vienna, but it did not make headway.

In 1913, at the Ninth Congress (Monaco), dissension became formulated in two phases in particular, one phase centering in Berlin, the other phase centering in Vienna.

The new secretary of the Deutsche Zoologische Gesellschaft headed a movement which was not in harmony with the assurances the commission had received from his predecessor.

From Vienna came three propositions which were not in harmony with the spirit of the Berlin Agreement on unanimity or with the Berlin, the Berne, and the Boston unanimous reports. The chief proponent of these three changes appeared before the commission to argue his case. In arranging for the hearing, in reply to the question as to how much time he desired to occupy, he said in effect: "If the commission adopts my views I shall not have to speak more than five or ten minutes, *but if the Commission does not adopt my views I shall want to speak six or eight hours or until the Commission does adopt my views.*" The gentleman from Vienna must be given credit for standing by his statement, for seventeen years later (1930), at Padua, his same three propositions were covered by a report[3] he made to the commission and by a very inclusive motion he made in the Section on Nomenclature.

Thus in 1913 the Berlin (1901) policy of conservatism, conciliation, unity and unanimity was threatened by one of radicalism, dictation and dissension. The radicalism centering at Vienna has continued and has gained adherents (*cf.* the Union of German-speaking Entomological Societies). The commission declined, in 1913 and 1927, to desert the Berlin (1901) conservatism for the 1913 radicalism.

Again in 1930, these same three propositions from Vienna were lost in the vote taken by the commission: 1930*A*[4] obtained in commission (out of a possible 18 votes) only 1 vote, 1930*D* only 2, and 1930*F*[5] only 4 votes.

Then came an unexpected action by the Section on Nomenclature, meeting with the commission to hear the commission's report. After the commission had reported that propositions known as 1930*A*[4], *D*, and *F*[5] had failed in commission, a prominent entomologist (Horn) from Berlin came to the support of the defeated Vienna proposition, 1930*F*[5], and introduced a resolution which presented the essential content of 1930*F* as a "definition"[6] instead of as an "amend-

[3] 1930*K*. "The Nomenklaturkommission des Verbandes Deutschsprachlicher Entomologenvereine has recently unanimously voted: 'Die Nomenklaturkommission des Verbandes Deutschsprachlicher Entomologenvereine empfiehlt der Internationalen Nomenklaturkommission, bei dem XI. Internationalen Zoologenkongress die Annahme der von dem British National Committee on Entomological Nomenclature Vorgeschlagenen Revision der Nomenklaturregeln (Proc. Ent. Soc. London, 3, 1928, pp. 2E–18E) mit den von Poche, Ent. Anz. 7, 1927, Nr. 1ff., beantragten Änderungen & einigen weiteren Änderungen in den gegenüber dem ersten Entwurf dieses Committee (1925) gemachten Zusätzen zu befürworten. Sie empfiehlt dem XI. Internat. Zoologenkongress wärmstens, diese Revision mit den gedachten Änderungen anzunehmen.' I personally heartily endorse this resolution."

[4] 1930*A*. "Wenigstens alle jene Anträge auf Abänderungen der, oder Zusätze zu den, Nomenklaturregeln, welche die absolute Majorität des jeweiligen Standes der Nomenklaturkommission und der Stimmen jener Kommissionsmitglieder erhalten haben, die an der Abstimmung über den bezüglichen Antrag teilnehmen, die innerhalb der Kommission am betreffenden Kongress selbst stattfindet, sind dem Plenum des Kongresses zur Beschlussfassung vorzulegen." A referendum on this proposition was conducted among American zoologists in 1927 with the result of 562 U. S. A. (+ 3 Canadian) votes against it to 4 votes for it. In reporting on this referendum to the 1927 (Budapest) Congress I said:

"(g) American zoologists hold that questions involving the principles and practices of nomenclature should be determined by a relatively small permanent organization, as exists at present in the international commission, and that they do not lend themselves to decision by a triennially temporary, essentially, and very likely, a geographically local majority such as the general meeting of the International Congress.

"(h) Accordingly, the American zoologists withhold their consent to the radical departure from the wise policy which was established at the Cambridge (1898) and Berlin (1901) Congresses and which has been accepted by the succeeding Congresses of 1904, 1907, 1910, and 1913."

[5] 1930*F*. "Veröffentlichungen, in denen der Autor gegen die Grundsätze der binären Nomenklatur verstösst, sind nomenklatorisch nicht zu berücksichtigen. Diese Grundsätze bestehen darin, dass der wissenschaftliche Name der Gattungen aus einem (einfachen oder zusammengesetzten), als lateinisches Substantivum gebrauchten Worte besteht, der der Arten dagegen aus zwei Teilen, nämlich dem Namen der betreffenden Gattung und einem auf diesen folgenden, der gleichfalls aus einem, als lateinisches Wort gebrauchten Worte (oder aus mehreren, einen Begriff bezeichnenden solchen im Sinne des Art. 15) besteht."

[6] Horn's resolution reads: "Der Kongress möge beschliessen, dass nur solche Publikationen als den Grund-

ment." Although the point was made by the secretary of the commission, that the "definition" amounted to an amendment, and that a formula (Suspension of the Rules) had been found and adopted and had been in force for seventeen years under which the difficult cases at issue could be handled under the existing rules, also that Europe and America could not be united on the plan now proposed by the Berlin entomologist, the "definition" was carried by a vote of 22 to 5. The four Americans present voted in the negative.

By all precedent, the resolution adopted by the meeting should have been referred to the commission. In fact this matter was discussed by the president of the Congress with the president and the secretary of the commission and it was understood by the secretary that this method was agreed upon. But instead of following precedent, the resolution was read in General Session, was put to immediate vote and, contrary to the agreement of 1901 and contrary to all precedents in nomenclature from 1898 to date, also out of harmony with the by-laws of the commission (in fact by totally ignoring the vote in commission), the resolution was carried in General Session by the procedure indicated in the proposed amendment 1930*A*[4] which had been defeated in commission by a vote of 14 to 1.

About two years ago, in an address on "The Future of Zoological Nomenclature," I said:

> *Stability of the International Rules.* By all odds, the greatest nomenclatorial question for the future, immediate and remote, is in regard to the stability of the international rules. . . . The immediate future of international rules depends primarily upon coming to a definite international understanding on the generic point as to how much importance is to be attached to the unanimous agreements of the past; and upon this understanding deductions can be based as to how much confidence is justified in majority (namely less than unanimous) agreements in the future. As compared with this fundamental generic point, all specific propositions for amendment to the international rules are secondary and relatively inconsequential.

The answer has been given by the Padua (1930) Congress which in its parliamentary procedure[4] has accepted the leadership of the zoologist from Vienna. While the commission still withheld acceptance to his views, the congress, overriding the report of the commission, voted for the essential content and intent of one of his three propositions[5] by the procedure indicated in a second.[4]

The questions naturally arise as to how the European and especially the German zoologists came to vote in favor of the Horn resolution[6] and how they came to accept parliamentary technique even more radical than that suggested in proposed amendment 1930*A*, especially after the Berlin agreement of 1901, based upon a demand by German zoologists, speaking in their capacity as administrative officers, namely, the president of the Berlin Congress and the secretary of the German zoological society.

In addition to holding in mind the ever-present possibility of a misunderstanding somewhere, the answer to this question is to be found in the fundamental fact that from our American view-point people in continental Europe are not so punctilious in parliamentary procedure as is customary in Great Britain[7] and North America. We do not necessarily have to assume bad faith as explanation for the vote in Padua, but rather an outstanding difference in average parliamentary technique and psychology between continental Europe and North America.

The principle involved, as seen by Americans, is that known as the "continuity of treaties": Two countries, X and Y, conclude a treaty (say in 1830); fifty years later it may happen that the personnel in the governments X and Y has changed 100 per cent., therefore that no individual in these two governments, in 1880, was personally responsible for the treaty which was made in 1830; nevertheless the governmental personnel in both X and Y in 1880 inherited governmental (*i.e.*, organization) responsibility to see that the treaty of 1830 is carried out—even if the individuals in question are personally opposed to the treaty provisions; usually treaties contain a provision that the high contracting parties may recede from the treaty after one year's formal notice that they intend to recede; but until that year is up the treaty is binding on the two governments, and any infraction against the terms of the treaty constitutes a violation of the treaty and according to its seriousness may be a *causa belli;* further, when one of the countries breaks the treaty the other country is thereby released from its provisions.

In the strict interpretation of the word, the international rules do not constitute a "treaty," for they have not been formally confirmed by the respective governments; but the fact remains that they were adopted by an international congress which assembled in Berlin at the invitation of the German government and that official delegates from the various governments, societies, museums, universities, etc., were in-

sätzen der binären Nomenklatur entsprechend angesehen werden sollen, in denen der Gebrauch von einem einzigen Wort als Gattungsname und von einem einzigen Wort als Speziesname konsequent durchgeführt ist. Zusammengehörige Wörter wie *cedo-nulli* und *noli me tangere* gelten als ein Wort.''

[7] Yet four zoologists representing Great Britain voted with the majority, a fact best explained by assuming a misunderstanding somewhere.

volved in the vote. They constitute, therefore, a quasi-treaty between scientific organizations or as older members of the commission have frequently termed it "a gentlemen's agreement." This is probably the nearest approach to an actual "treaty" which is possible in the matter of nomenclature.

Only two of the fifteen commissioners of 1901 are still members of the commission, and the two leaders (from Berlin and Vienna) back of the Horn resolution are not and never have been members of the commission. From the American point of view the responsibility for the unanimous report demanded by officers of the British (1898) and the German (1901) congresses and accepted by the commission is an organization responsibility; any member of the congress or the commission is at liberty of course to hold any view he wishes, but as a member of the organization he *inherits* the *responsibility* adopted by the organization in 1898 and 1901 and any deviation from the agreement of 1901 (later written into the by-laws of the commission) constitutes a breaking of that agreement regardless of the fact that the men voting for the break act in absolutely good faith.

The by-laws of the international congress itself are not very detailed. In 1927 a subcommittee of two members of the Permanent Committee was appointed to redraft the by-laws of the congress. This redraft was presented to the Permanent Committee at Padua in 1930 and will be submitted eventually to the prominent zoological societies of the world for consideration. This manuscript contains provisions which, if enforced, would absolutely prevent the action taken by the Padua Congress on the Horn resolution. In the absence of a set of by-laws for the congress (as distinguished from the commission) excluding the Padua vote on the Horn resolution, opinion will be divided as to the validity of the Padua vote.

Many Europeans will maintain that the congress was free to adopt any resolution proposed.

Zoologists in the United States will almost if not entirely unanimously contend that the action was (*a*) invalid from a parliamentary standpoint, (*b*) contrary to all precedents in nomenclature from 1898 to 1930, (*c*) contrary to the spirit and effect of the 1901 Berlin agreement, (*d*) contrary to the words of the same except that the Horn resolution was presented as a "definition" while in effect it amends, (*e*) contrary to the by-laws of the commission, (*f*) contrary to the Padua 1930 vote 14 to 1 in the Commission on Nomenclature against Proposition 1930*A*, (*g*) even more radical than Proposition 1930*A* which has been consistently opposed by American zoologists, (*h*) that it makes procedure in nomenclature subject to a chance majority vote (on any motion suddenly introduced from the floor, without international notice) determined by the geographical locality of the meeting of the congress, and (*i*) makes the rules of nomenclature subject to sudden and recurrent (three to five year) changes, thus making them unstable and without reasonable protection to the views of the minority present or to the views of countries and specialties not represented or poorly represented at the congress.

For thirty-five years I have favored and worked for internationalism in nomenclature. It is now difficult for me to deny that I am disillusioned in view of the Padua vote. The question arises in my mind whether it is really worth while to spend further time discussing and rediscussing the same old problems and to make agreements in good faith only to learn later that some of our colleagues because of other premises and parliamentary technique different from that which we follow feel at liberty to disregard these early engagements of their predecessors because they themselves were not members of the commission when the agreement was actually made or for other reasons, and to whom a *res judicata* means so much less than it does to us.

If there has been any misunderstanding on either side, it is time this should be cleared up.

I unreservedly maintain that the Padua vote on the Horn resolution was unparliamentary and invalid, but I have grave doubts whether this point of view will be accepted by certain of my friends and colleagues in central Europe.

From the point of view based on the principle of the continuity of treaties and its application to a gentlemen's agreement I find it difficult to escape the conclusion that the action of the 1930 Padua Congress automatically releases (in fact divorces) from further cooperation with the International Congress or the International Commission on Nomenclature all zoologists who gave their adherence to these rules on basis of the Berlin, 1901, Agreement, or on basis of the by-laws of the commission, and who count permanency and stability of rules as one of the essentials in nomenclature.

American zoologists face the problem of defining their position as to the immediate future of nomenclature. It is not a question of the Americans deciding to revolt. The revolt has already taken place on the part of the Europeans under the leadership of Berlin following a seventeen-year preparatory propaganda from Vienna. The question before the Americans is whether they will submit to a modification of the principle on basis of which American zoologists allied themselves to the international rules (all other points are secondary in comparison), or whether they take the position that it is better policy for American and European zoologists to wish each other good luck and for each of these two groups to settle its own problems in nomenclature by its own methods.

The point is striking that so many divergent and different propositions emanate from Berlin. The question lies near as to how united the Germans really are on the principles and practices of nomenclature and how definitely they understand just what they want and how permanently they are disposed to carry out *majority* agreements in view of the fact that the history of nomenclature since 1910 has demonstrated that they no longer emphasize the importance to be attached to *unanimous* agreements. Frankfurt a.M. seems to be at least one center which has a united policy.

If, instead of arguing on the premise of the principle of continuity of treaties, one wishes to adopt the view that a member of the congress or of the commission, in 1930, who was not personally a party to the 1901 agreement is at liberty to disregard the existence of that agreement, certain conclusions seem to follow logically, *i.e.*, (*a*) only the two surviving members of the 1901 commission bear any obligation to the 1901 agreement, (*b*) only those persons who voted in the affirmative on the Horn resolution bear any obligation to that resolution, (*c*) the international rules are, always have been, and always will be a scrap of paper, and (*d*) American zoologists should now determine whether they will accept this new interpretation and try to adhere to rules which Europe will nearly always[8] be in a position to modify at will by a local geographical majority voting on a motion made from the floor in the Section on Nomenclature with right of vote by any person who has qualified by payment of the five dollar membership fee.

Whichever premise is followed, it is obvious that American zoologists should make their position unambiguous, for "silence gives consent."

To follow the early example of the A. O. U. in the hope of making more rapid and more lasting progress does not mean that the work of the past forty years will be thrown away because of nomenclatorial divorce. The subject of the theory and practice of nomenclature is more generally understood now than formerly and eight or nine sets of rules (national or international, general or special) will have been reduced essentially to two sets which differ from each other only in a few important features. Further the feasibility of a continuing international unity is not obvious under existing different view-points as to the importance to be attached to agreements, to methods of parliamentary procedure and to a *res judicata*.

The technical nomenclatorial question 1930*F* at issue in the 1930 Congress is trivial in comparison with the revolutionary and radical principle involved in 1930*A*[4, 6] (of which it became a test case). 1930*A* (accepted in an even more radical form by the congress) makes the rules subject to change every few years by a chance majority vote in the Section on Nomenclature (even in opposition to the vote in the Commission on Nomenclature) and the General Session, determined by the geographical center in which the congress meets and not safeguarded by the conservatism of a permanent commission. To this the American zoologists will never consent if I interpret correctly their votes of 1927 and 1930 which have reached my office. If the action of the 1930 Congress stands (and I see no chance to revise it for five years to come) a nomenclatorial split between Europe and the United States seems inevitable—in fact it has already been brought about by the Padua vote.

1930*F*, Binary *vs.* Binomial: The question of binary *vs.* binomial, the point on which the Padua Congress voted, has a long and somewhat tedious history which need not be reviewed here.

The issue as based on 1930*A*[4, 6] is clear cut and need not be complicated at present by discussion of other points. Suffice it to say that the commission has passed upon the principles of 1930*F*[5] by unanimous vote, that it later (in Opinion 20) clearly illustrated the meaning of its vote, and that propositions to revise the vote have failed in the commission on no less than four occasions.

Conclusion: I recommend that a meeting of American zoologists interested in nomenclature be called at an early date. If a preliminary meeting be held in Washington, D. C., many members of committees on nomenclature are immediately available. This will include not only members of Washington committees but also some of the members of practically every American national committee on zoological nomenclature. This joint committee can canvass the entire situation and make recommendations to the Washington societies which they represent, and members of national committees who are present can report to their national committees as to the action taken by the Washington joint meeting. The national committees can then report to their societies with recommendations.

The foregoing plan can crystallize American opinion very rapidly.

I pledge myself to abide by the decision of the American zoological profession thus represented as to whether I remain with or resign from the international commission—regardless of my own personal views. But if Americans accept the Padua vote, I shall feel it necessary to resign at least as Secretary to the Commission on the ground that some person in harmony with the major and fundamental policies of the commission should shoulder the responsibilities necessarily connected with the very unenviable and unpopular position as its *Capra hircus*.

[8] Of the eleven congresses thus far held, ten have met in Europe, one in the United States.

OBITUARY

GEORGE PETER DREYER

George P. Dreyer was born in Baltimore, September 22, 1866, and until 1900 his life was spent in that city. He was educated in Baltimore City College and in the Johns Hopkins University. Following his A.B. degree from Hopkins in 1887, he was fellow in physiology during '88 and '89 under the distinguished physiologist, Newell Martin, and received his Ph.D. degree in 1890.

Dr. Dreyer's early intention was to study medicine, but his contacts at Hopkins with Martin, and later with Howell, definitely brought him to decide on physiology as a career; a decision which he never regretted. He valued highly the acquaintances made in those earlier days. Such men as Henry Sewall, E. G. Conklin, T. H. Morgan, A. C. Abbott, C. W. Greene, Percy Dawson, Joseph Erlanger and David Lingle left pleasant and lasting memories.

From 1890 until 1900 he was associate professor at his Alma Mater, and during this time he became the master of physiological technique and manipulation for which he was justly famous. No one ever saw Professor Dreyer operate without admiring his skill. As a teacher he was as successful as he was technically skillful. His demonstrations were uniformly successful, and accomplished with a facility which often hid the actual difficulties. His first humiliation occurred when he had to use spectacles to catheterize Wharton's duct. While he accepted this premonition of approaching age philosophically, he frequently spoke of it.

In 1900 Dr. Dreyer came to Chicago as professor of physiology and physiological chemistry in the College of Physicians and Surgeons, which had formed an affiliation with the University of Illinois. The conditions were far from ideal and far from what he had anticipated. The affiliation proved to be loose and was soon broken, and for a time, the College of Physicians resumed its proprietary status. During the interim Dr. Dreyer remained, hoping for a reunion which would bring university standards, conditions and ideals. Satisfactory conditions, however, were not established until about 1915, and to make these conditions operative Dr. Dreyer assumed the office of dean. In this office he developed university working conditions and ideals for others, but at the cost of his health and with the sacrifice of research for many years. While acting as dean, he suffered an attack of pneumonia, followed by empyema, which left him physically incapacitated for more than a year. While he was afterwards mentally alert and able to resume professional duties, he had not the physical stamina demanded for research. Until the time of his death on February 27, he was compelled to avoid unnecessary exertion and to adopt measures to retain and to promote health.

As a health-promoting measure, as well as from actual pleasure, he spent much of his leisure time in gardening, and the flower garden of his suburban home was the rendezvous of amateurs and friends.

Dr. Dreyer was a pioneer physiologist in Chicago; when he came many men on the Atlantic seaboard could visualize only vulgarity and incivility west of the Alleghenies. So far as physiology was concerned this was "pragmatically" true. Only Jacques Loeb, at Chicago, and Winfield Scott Hall, at Northwestern, had preceded him. A. P. Mathews, David J. Lingle, George Neil Stewart, C. C. Guthrie and Alexis Carrel soon followed. All these men bore the burden and worked in the heat of the day, but none of them were exposed to the disruptive ultra-violet rays as was Dreyer. An ancient prophet said that old men dream dreams, and the young men see visions. Dreyer was young and had vision, and Chicago to-day is physiologically what he hoped it would be. His only regret was that he was unable to contribute more to his chosen profession. His best known research was the discovery of secretory nerves to the adrenal glands, and his work on blood proteins and differential respiration. In 1899, by using large quantities of the adrenal venous blood, he was able to give the first convincing proof that the blood pressure raising principle is actually secreted into the blood flowing from the gland. His findings were afterwards fully confirmed by other workers. More important than his discoveries were his generous aid to others, and the preparation of the field for others to reap where he sowed.

Within the past two years, he devoted much time to planning a new laboratory in which he hoped to again resume research work. He lived to see this laboratory almost ready for occupancy, but after thirty years in the wilderness of promise he was allowed to see but not to enter, the promised land.

During his thirty years' service to the University of Illinois, Professor Dreyer came in contact with thousands of students and graduates. He was known to them as a great teacher, a profound student, a gentleman and a friend.

H. A. McGuigan

University of Illinois,
College of Medicine,
Chicago

RECENT DEATHS

Dr. L. H. Pammel, professor of botany since 1889 at the Iowa State College, died on March 23, while returning from a winter in California. Dr. Pammel was in his sixty-ninth year.

DR. JOHN EDGAR TEEPLE, consulting chemist, known for his work in the development of the potash industry in the United States, died on March 23, at the age of fifty-seven years.

EDWARD DWIGHT PRIEST, designing engineer in the railway department of the General Electric Company, with which he was connected for thirty-four years before his retirement in 1926, died on March 26.

SCIENTIFIC EVENTS

AUSTRALIAN VITAL STATISTICS

THE Sydney correspondent of the *Journal* of the American Medical Association reports that at the end of 1929 the population of Australia reached the total of 6,414,372. The rate of growth during 1929 was 1.22 per cent. and for the ten years 1.92 per cent., which is probably the highest rate of increase in the world. Excess of births over deaths contributed 70.5 per cent. of the total increase, and net immigration 29.5 per cent. The density of population of Australia is only 2.16 persons per square mile, and varies from one person per hundred square miles in the Northern Territory to 20.22 persons per square mile in Victoria.

The birth rate for 1929, 20.31 per thousand of population, was the lowest ever recorded. Compared with many other countries the Australian rate is low, but it is fortunately accompanied by a low death rate, giving a rate of natural increase that is equaled in few countries. Extranuptial births numbered 4.70 per cent. of all births registered. The proportion of multiple births is one case of twins in every 98 confinements and one of triplets in 14,242 confinements. The average number of children per mother was 2.96, against 2.99 in 1928.

During the year, 60,857 deaths were registered, corresponding to a rate of 9.55 per thousand of the population. This rate was slightly above the average of the previous five years, but nevertheless compares most favorably with other countries. The principal causes of death were: heart diseases, 15.3 per cent.; cancer, 10.3 per cent.; violence, 6.0 per cent.; cerebral hemorrhage, 5.8 per cent.; tuberculosis, 5.7 per cent.; nephritis, 5.6 per cent.; pneumonia, 4.9 per cent. The number of deaths in childbirth was 5.1 per thousand children born. The infant mortality rate for Australia (deaths of children under the age of 12 months) per thousand children born was 51. This rate is the lowest ever recorded in Australia and is, with the exception of New Zealand, the lowest in the world. The rate for New Zealand is 34.

THE PACARAIMA-VENEZUELA EXPEDITION

MEMBERS of the American Museum of Natural History, the American Geographical Society and the New York Botanical Garden are organizing an expedition to the unexplored uplands of southern Venezuela. The plans for this undertaking, which is scheduled to begin the middle of August, provide for a comprehensive scientific survey of the region. In order to facilitate the administrative and executive details of organization a membership corporation has been formed under the title "The Pacaraima-Venezuela Expedition Inc." At the first meeting of the board of directors Mr. H. E. Anthony, curator of the department of mammalogy of the American Museum of Natural History, was elected president of the corporation; Dr. H. A. Gleason, curator of the New York Botanical Garden, vice-president; R. R. Platt, head of the department of Hispanic-American research of the American Geographical Society, secretary, and Fred H. Smith, bursar of the museum, treasurer. The expedition will be led by staff members from the three institutions above mentioned. Those taking part are: Leader, Mr. H. E. Anthony; assistant leader, Mr. G. H. H. Tate, geologist, who has been on seven expeditions to South America for the American Museum; C. C. Graves, formerly of the Field Museum of Natural History expedition to Alaska and the Arctic, geologist; W. B. Miller, Jr., who has traveled in southwest United States, west and southwest Venezuela and northern Rhodesia, topographer and geologist; C. B. Hitchcock, who has already been to Venezuela, botanist; A. C. Smith, acquainted with Peru and Brazil, chief pilot and topographer; G. A. Thorn, aerial photographer and pilot; A. C. McKinley, an assistant aeroplane mechanic, and C. Broten, the three last mentioned having been members of the Byrd Expedition.

The region of exploration consists of about 40,000 square miles at the headwaters of the Orinoco River between Mt. Roraima, a sandstone table-mountain at the junction of Venezuela, British Guiana and Brazil, and Cerro Diuda, a mountain similar to Mt. Roraima, about 400 miles south, on the upper Orinoco. The expedition plans to map this region by means of aerial photography; to outline its physiography and geology; to make collections of its animal and plant life and to study the Indian tribes.

The plan of the expedition has been presented to General Gomez, President of Venezuela, who is in complete sympathy and has assured the leaders of his full cooperation.

SHENANDOAH PARK HIGHWAY

ONE of the most scenic highways of the country, that may ultimately extend for 150 miles, is to be built

along the summit of the Blue Ridge Mountains throughout the length of the Shenandoah National Park area in Virginia. Plans for the construction of this spectacular skyline drive are now being completed by the National Park Service in cooperation with the United States Bureau of Public Roads.

In this connection, decision was reached to limit main-road construction in the park area to this particular project. Already there are roads just outside the proposed park boundary and completely surrounding it, and in addition two lateral roads cross the area. These are the Lee Highway between Sperryville and Luray and the Spottswood Trail connecting Standardsville and Elkton. The tentative plan to construct another lateral road either by way of the Rapidan or the Robertson River Valleys to meet the ridge road has therefore been abandoned.

These final plans are based upon the recommendations of Chief Architect Thomas C. Vint and Assistant Landscape Architect Charles E. Peterson, of the National Park Service, and followed a thorough investigation by them of local conditions. Preliminary surveys have already been made by the Bureau of Public Roads.

While the proposed highway eventually will follow the skyline of the ridge from Front Royal to Rock Fish Gap, between Afton and Waynesboro, the first unit to be taken up for construction is that portion, 50 miles long, between Panorama (Thornton Gap) and Swift Run Gap. At the latter point the road will connect with the Spottswood Trail.

The highway system as proposed under this general development plan will cover the park area more thoroughly than any in the western parks, as it is believed logical to go farther in road development in an area where travel is bound to be heavy owing to its location in or near the more densely populated portion of the United States. Further high-standard road developments, however, will be consistently opposed, since one of the major duties of the National Park Service is to preserve and protect the natural conditions of the wilderness.

Authority for the construction of the highway in the Shenandoah area before the actual establishment of the park was given to the National Park Service that employment might be provided for the sufferers from drought and adverse economic conditions in the Shenandoah Valley.

THE SPRINGFIELD MUSEUM

ACCORDING to *Museum News* plans for the James Philip Gray Art Museum and for an addition to the Natural History Museum have been accepted by the board of directors of the City Library Association, Springfield, Massachusetts. The plans are by E. L. Tilton and Arthur M. Githens, of New York, and were chosen from a number submitted in competition. They call for two-story structures harmonizing in style and materials with the buildings already on the city library quadrangle, which include the library, the William Pynchon Memorial, the Natural History Museum and the Art Museum. The new art building will be erected on the site now occupied by the George Walter Vincent Smith home; the natural history addition will be on the west side of the quadrangle. The art building will cost about $350,000; the addition to the Natural History Museum, about $160,000.

The James Philip Gray Art Museum will house paintings and will thus provide a much needed supplement to the present art building, which is used principally for decorative arts. Pictures will be purchased with the income from a fund of more than $750,000 bequeathed to the association by Mr. Gray. The natural history addition will furnish needed additional exhibition space, and space for lectures and for the children's work.

Building is expected to begin this summer. The building committee consists of Nathan D. Bill, Edward Kronvall, William B. Kirkham and Hiller C. Wellman. This committee arranged the competition for selecting the architect and named the jury of five to judge the merits of plans submitted. On this jury were Theodore Sizer, of Yale University; Henry R. Shipley and Frederick L. Ackerman, architects of Boston and New York, respectively; Mr. Kirkham and Mr. Wellman, chief librarian of the city library. The successful competitors, Tilton and Githens, have been chosen as architects for the construction of the two buildings.

THE THIRD INTERNATIONAL CONGRESS OF EUGENICS

THE Sixth International Congress of Genetics will be held under the presidency of Professor T. H. Morgan, at Ithaca, New York, in 1932, beginning on August 24. Immediately preceding this congress the Third International Congress of Eugenics will meet in New York City.

According to a statement in the last issue of *Eugenical News*, the First International Congress of Eugenics, which was sponsored by the Eugenics Education Society of Great Britain, was held in London in 1912, under the presidency of Major Leonard Darwin. The second congress in this series was held in New York in 1921, under the presidency of Dr. Henry Fairfield Osborn. The third congress will be held at the American Museum of Natural History, New York, from August 20 to 23, 1932, under the presidency of Dr. Charles B. Davenport, director of the Department of Genetics of the Carnegie Institution of Washington and organizer of the Eugenics Record Office.

The first congress in 1912 set up a Permanent In-

ternational Eugenics Committee which built up the international collaboration which made the second congress possible. This Permanent International Eugenics Committee was changed, in 1921, to the Permanent International Eugenics Commission, which in 1925 developed into the present International Federation of Eugenic Organizations, which, among other functions, fosters collaboration among the several nations in their eugenical researches between congresses, and sponsors international congresses from time to time. Dr. Davenport was formally selected as president of the third congress by the ninth meeting of the International Federation of Eugenic Organizations which met at Farnham, England, in September, 1930. This same meeting of the federation duly committed to the American delegation the function of organizing and managing the third congress. In response to these two votes of the federation, Dr. Davenport called the American delegation together at the Yale Club last November. This delegation, by vote, formally accepted the responsibility and, in accordance with the actions already taken by the federation and the authority granted, perfected and announced the following working organization and preliminary plans for the congress.

President—Charles B. Davenport, Cold Spring Harbor, Long Island, N. Y.

Honorary Presidents—Leonard Darwin, Henry Fairfield Osborn.

Vice-presidents—Victor Delfino, Argentina; H. Reichel, Austria; A. Govaerts, Belgium; D. F. Ramos y Delgado, Cuba; V. Růžička, Czechoslovakia; Sören Hansen, Denmark; A. Lüüs, Esthonia; Harry Federley, Finland; Georges Schreiber, France; Alfred Ploetz, Germany; Sir Bernard Mallet, Great Britain; Corrado Gini, Italy; Marianne Van Herwerden, Netherlands; Jon Alfred Mjøen, Norway; Leon Wernic, Poland; N. K. Koltzoff, Russia; H. B. Fantham, South Africa; H. Lundborg, Sweden; O. Schlaginhaufen, Switzerland; Irving Fisher, United States.

Treasurer—Frederick Osborn, 52 Broadway, New York, N. Y.

Secretary—Harry H. Laughlin, Cold Spring Harbor, Long Island, N. Y.

Chairmen of Administrative Committees—Scientific Papers and General Program, Charles B. Davenport; Entertainment, Mrs. Charles Cary Rumsey; Finance, Frederick Osborn; Exhibits, Harry H. Laughlin; Publication and Publicity, Leon F. Whitney.

Managing Committee—Charles B. Davenport, *chairman*; Irving Fisher, *vice-chairman*; Clarence G. Campbell, Madison Grant, Frederick Osborn, Leon F. Whitney; Harry H. Laughlin, *secretary*.

An exhibition covering the present status of eugenical research will be held at the museum. It is planned to open this exhibition on August 22, and to continue it, open to the public, until September 22.

The members of the congress will be taken on an excursion to Cold Spring Harbor on Sunday, August 21, to visit the Eugenics Record Office and the Station for Experimental Evolution which, together, constitute the Department of Genetics of the Carnegie Institution of Washington.

SCIENTIFIC NOTES AND NEWS

SIR ALFRED EWING, lately principal and vice-chancellor of the University of Edinburgh and previously professor of applied mechanics at the University of Cambridge, has been nominated as president for 1932 of the British Association for the Advancement of Science.

THE Hillebrand Prize of the Chemical Society of Washington has been awarded to Dr. Claude S. Hudson, of the U. S. Public Health Service, with special reference to his work on the ring structure of sugar.

THE Society of Arts and Sciences, New York, has awarded its 1931 medals for "outstanding scientific achievement" to Dr. Harlow Shapley, director of Harvard College Observatory, and to Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research.

THE American Geographical Society announces the award of the David Livingstone Centenary Medal to Captain Hjalmar Riiser-Larsen, for his work in the Antarctic as leader of the *Norvegia* expedition in 1929–1930. He has returned to the Antarctic, joining the *Norvegia* early this year, to take charge of the latter part of the season's work. Captain Riiser-Larsen has also participated in two notable Arctic expeditions—the Amundsen-Ellsworth Polar Flight of 1925 and the flight of the *Norge* across the Polar Sea in 1926.

AT a dinner of the directors of the American Institute of Mining and Metallurgical Engineers held last November, Dr. Henry S. Drinker, president emeritus of Lehigh University, was presented with a gold watch bearing the following inscription: "Henry Sturgis Drinker—Founder—American Institute of Mining and Metallurgical Engineers from his appreciative fellow members—1930." Dr. Drinker observed his eightieth birthday on November 8, 1930.

A DINNER in honor of Professor E. B. Wilson, as retiring president of the Social Science Research Council, was given at the University Club, New York,

on the evening of March 27. The speakers included Professor Charles E. Merriam, of the University of Chicago; Professor Wesley C. Mitchell, of Columbia University; Dr. Waldo G. Leland, permanent secretary of the American Council of Learned Societies; Dr. John C. Merriam, president of the Carnegie Institution of Washington, and Professor Arthur M. Schlesinger, of Harvard University, who presided.

At the recent meeting in Baltimore of the American College of Physicians, Dr. S. Marx White, president-elect of the college, was inducted as president. Dr. Francis M. Pottenger, of Monrovia, California, president and medical director of the Pottenger Sanatorium, was chosen president-elect for 1932. He will assume office at the meeting next year at San Francisco. Other officers elected were: *First Vice-president,* Dr. Alfred Scott Warthin, of Ann Arbor, Michigan; *Second Vice-president,* Dr. Charles G. Jennings, of Detroit; *Third Vice-president,* Dr. John A. Lichty, of Clifton Springs, New York.

A Harvard Chapter of Sigma Xi was inaugurated on March 28. Professor Harlow Shapley, of Harvard College Observatory, presided, and Professor George W. Stewart, national president of the society; President Lowell; Dr. Karl T. Compton, president of the Massachusetts Institute of Technology; Professor Walter H. Snell, of Brown University; Professor Jerome W. Howe, of the Worcester Polytechnic Institute, and Professor John S. Nicholas, of Yale University, spoke. Professor Shapley was elected president of the chapter and Professor Kirtley F. Mather secretary.

Dr. T. Wayland Vaughan, director of the Scripps Institution of Oceanography, University of California, at La Jolla, has been elected a member of an advisory committee on the "General Bathymetric Chart of the Oceans" of the International Hydrographical Bureau of Monaco.

Professor Karl Goebel, director of the botanical garden of the University of Munich, has been invited to be Speyer visiting professor at the Johns Hopkins University for 1931–32.

Professor Howel Williams, at present in California, has been appointed professor of geology at the University of Wales, Aberystwyth.

Dr. E. E. Clayton has resigned his position as associate in research in the department of botany of the New York Agricultural Experiment Station to become plant pathologist in the Office of Tobacco Investigations of the U. S. Department of Agriculture.

Dr. William C. Young, instructor in biology at Brown University since 1928, has received a National Research Council fellowship for study abroad and will continue his work under Professor von Mollendorff at the University of Freiburg, Germany, next year. He is a graduate of Amherst in the class of 1921.

The J. T. Baker Chemical Company Research Fellowship in Analytical Chemistry, Midwest Division, has been awarded to H. C. Fogg, formerly instructor in chemistry at the University of New Hampshire. He will work at the University of Michigan under the direction of Dr. H. H. Willard.

Dr. R. B. Lindsay, associate professor of physics at Brown University, has accepted an invitation to offer a graduate course in acoustics at the Polytechnic Institute of Brooklyn in the second semester of the academic years, 1931–32. He will go to the institute as visiting professor of theoretical physics.

Dr. Frank B. Cotner, associate professor of botany and bacteriology in Montana State College, will during the coming summer be a member of the staff of the department of botany at the University of Michigan. Dr. Cotner is acting head of the department of botany and bacteriology during the present academic year in the absence of Professor D. B. Swinglé, who is on sabbatical leave at the University of Wisconsin, where he is engaged in research work.

Dr. Harry H. Love, professor of plant breeding at Cornell University, has left for China, where, during the next three years at the University of Nanking, he will organize plant improvement projects for the Chinese Government, under the auspices of the joint Cornell-Nanking University-International Education Board. The Chinese Government is preparing to take over full control of the work of this organization.

Mr. M. W. Stirling, chief of the Bureau of American Ethnology, has been excavating a mound on Horr Island off the west coast of Florida. Toward the end of March he planned to go to Cape Canaveral to look over some sites, thence to Miami and by airplane to Haiti, where he will join Dr. Wetmore, Mr. Parish and Mr. Krieger on a short visit to the archeological sites found by Mr. Parish on Vache Island. Mr. Stirling is expected to return to Washington the early part of April.

Dr. Roy Chapman Andrews sailed on March 28 for China to search on the plains of eastern Mongolia for the fossils of the pre-Peking man.

Dr. Samuel W. Stratton, chairman of the corporation of the Massachusetts Institute of Technology and formerly director of the United States Bureau of Standards at Washington, sailed on March 28 for Europe. He goes to Paris, where he will be the representative of the government at the forthcoming meeting of the International Committee of Weights and Measures. This conference will be held at the In-

ternational Bureau of Weights and Measures at Sèvres from April 10 to April 22. Dr. Stratton will return to America immediately after the conclusion of the meeting.

DR. WILLIAM H. WELCH, of the Johns Hopkins University, gave the principal address at the annual banquet of the American College of Physicians meeting at Baltimore.

DR. THEOBALD SMITH was a visiting lecturer at the School of Tropical Medicine in San Juan, Porto Rico, during a two-week period in March. He gave a series of lectures to the faculty and students and studied the medical problems of the island. Dr. Walter W. Palmer, Bard professor of medicine at the College of Physicians and Surgeons, Columbia University, visited the school for ten days in March, giving several lectures and holding clinics at the University Hospital.

DR. M. M. LEIGHTON, chief of the State Geological Survey of Illinois, addressed the St. Louis University Sigma Xi Club on March 17, on "Recent Studies Bearing on the Chronology of the Glacial Deposits of the Mississippi Valley States."

DR. WALTER R. MILES, professor of psychology in Stanford University and visiting research professor of medicine in Yale University, on March 25 addressed a graduate seminar in psychology at Brown University on "Visual Fixation." In the evening he delivered a Marshall Woods lecture on "Dilute Alcoholic Beverages and Human Behavior."

DR. HERBERT A. EVANS, of the University of California, who was to give the Bacon lectures at the University of Illinois College of Medicine on March 31 and April 1, is suffering from an attack of influenza, and was unable to give the lectures as announced.

THE 1931 Messenger Lectures at Cornell University will be given in April by Dr. Thomas H. Morgan, director of the William G. Kerckhoff Laboratories of the Biological Sciences at the California Institute of Technology. The series, which has for its subject "The Experimental Study of Organic Evolution," will comprise twelve lectures, starting on April 9 and continuing until April 24. The Messenger Foundation, established in 1923 through a bequest of about $77,000 in the will of Dr. Hiram J. Messenger, of Hartford, Connecticut, provides for an annual course of lectures on some phase of the evolution of civilization, "for the special purpose of raising the moral standard of our political, business, and social life." Professor Morgan will speak on the following twelve topics: The Mutation Theory and its Chromosomal Background; The Cellular Basis of Heredity and Evolution; Mendelian Inheritance and Its Bearings on the Evolution Theory; Artificial Selection, Mutation and Evolution; Adaptation and Natural Selection; Variability and Selection; The Theory of Sexual Selection and Hormones; Embryonic Development and Its Relation to Evolution; The Inheritance of Acquired Characters and Mutation; The Social Evolution of Man: Nature and Nurture; Evolution as a Response to the Order of Nature; Mechanistic and Metaphysical Interpretations of Biology and Evolution.

FOR the third year the Geographic Society of Chicago is offering a research series of three lectures in Fullerton Hall of the Art Institute of Chicago. The titles for 1931 are as follows: Dr. Darrell H. Davis, the University of Minnesota, "Facts of the Human Habitat in the Central Northwest"; Dr. Robert B. Hall, the University of Michigan, "The Yamato Basin," and Dr. Wellington D. Jones, the University of Chicago, "Land Occupance in Dairy Farming Communities Adjacent to Metropolitan Chicago."

AT the Vanderbilt School of Medicine lectures have been arranged as follows: On March 31 by Dr. George R. Minot, professor of medicine at the Harvard Medical School, under the auspices of the Alpha Omega Alpha Honorary Society; on April 16 by Dr. Charles R. Stockard, professor of anatomy at the Cornell Medical School, under the auspices of the Phi Beta Pi fraternity, which has established an annual lectureship; on April 4 by Dr. G. F. McCleary, of the British Ministry of Health, who will speak on "The Control of Narcotic Drug Addiction." Dr. McCleary is coming to this country primarily for the purpose of delivering one of the DeLamar Lectures at the Johns Hopkins University School of Medicine.

THE annual joint meeting of the Wisconsin Academy of Sciences, Arts and Letters, the Wisconsin Archeological Society and the Midwest Museum Conference will be held at Ripon College on April 10 and 11. An illustrated lecture on North African Ethnology will be given by Alonzo W. Pond on the evening of the tenth.

PROFESSOR GEORGE T. HARGITT, Duke University, Durham, North Carolina, secretary of section F of the American Association for the Advancement of Science, writes that in connection with the summer meeting of the association in Pasadena from June 15 to 20, Section F (Zoology) will hold such sessions as are necessary for the accommodation of papers presented by its members. The following information should be furnished by those desiring a place on the program: Title of paper; abstract of about 200 words; charts or lantern to be used; microscopes needed for demonstration; under what group the paper should be listed—physiology, embryology, cytology, comparative

anatomy, genetics, parasitology, protozoology. Papers will be limited to 15 minutes. Such information should be sent direct to Dr. Bennet M. Allen, department of zoology, University of California, Los Angeles, who is in charge of the program arrangements. Titles, abstracts and other information must be in his hands not later than May 15.

THE twenty-fifth annual convention of the Illuminating Engineering Society will be held in Pittsburgh, Pennsylvania, from October 13 to 16, inclusive, 1931. Headquarters will be established at the William Penn Hotel. As in previous years, a preconvention session of Lighting Service Engineers will be held on the day preceding the official opening of the convention. A special feature of this year's meeting will be the observance of the society's silver anniversary.

THE scientific session of the American Heart Association will be held on June 9, from 10:00 A. M. to 5:00 P. M., in the Main Surgical Clinic of the Pennsylvania Hospital at Eighth and Spruce Streets, Philadelphia.

Nature, quoting from *Chemistry and Industry*, states that the International Atomic Weights Commission will meet for the first time since the war. The Federal Council for Chemistry, in view of the progress made in ensuring the truly international character of the Union Internationale de Chimie, has decided to dissolve the existing committees on the chemical elements and to appoint a new international committee. This is to consist of G. P. Baxter (United States), O. Hönigschmid (Munich), P. Lebeau (Paris), R. J. Meyer (Berlin), and Mme. Curie. Professor G. Urbain has been elected honorary president of the committee, which has been charged with the duty of preparing an annual international table of atomic weights. New committees on isotopes and radioactive elements are in course of formation.

IT is estimated that £700,000 will eventually become available for cancer research as a result of a provision in the will of Montague Stanley Napier, motor car manufacturer and airplane designer, who died in Cannes in January.

MRS. MARY E. LIBBEY, widow of Dr. William Libbey, of Princeton University, has made a gift of $6,000 to the Graduate School of Geography at Clark University. She had already given $1,000 and Dr. Libbey's collection of geographical instruments, a special card catalogue and a collection of 14,000 lantern slides to found the Libbey Memorial Library at the university.

ACCORDING to *Nature* an experimental room has been set up at the London School of Hygiene and Tropical Medicine in which it is possible to reproduce by means of an air-conditioning plant varied climatic conditions and any temperature, humidity or air movement which may occur in factories or mines. Experimental subjects rest or work under the conditions to be investigated, and by observation of the pulse, body temperature, skin temperature, loss of weight due to sweating, and expenditure of energy by measuring the air breathed and oxygen used, it is possible to study the effect of such air conditions on the human body.

Museum News reports that the government program for improvements in the City of Washington includes the demolition of the Army Medical Museum building which is on the Mall near the Smithsonian Institution. The exhibits will be transferred to a new building to be erected at the Walter Reed Medical Center, if tentative plans formulated by the War Department are put into effect.

THE will of Egbert C. Fuller, president of the E. C. Fuller Company, of New York, who died at New Haven on March 5, provides for the establishment of a fund which the executors estimate will reach $1,500,000, to be used "for alleviation of suffering from disease and especially for the control of cancer." Mr. Fuller, in his will, directed that the fund be known as the Anna Fuller Fund, in memory of his wife, who died from "this painful disease." The fund may be used according to the will only for research as to its cause, treatment and care; the education of the public as to its prevention and treatment and the actual treatment of persons suffering from the disease. While there is hope of preventing cancer, Mr. Fuller provides in his will that the fund shall not be used for the treatment of persons suffering with the disease "except as incidental to such research and education." The will also provides for the creation of the Anna Fuller memorial prize which is to be given to any person or persons who "make a real and outstanding contribution to knowledge of the cause, care and prevention or cure of cancer." Such award or awards shall not in any five-year period exceed the sum of $25,000. Prizes are to be awarded upon the recommendation of the president of the American Medical Association, the dean of the Johns Hopkins Medical School, and the dean of the Harvard Medical School.

CONTROL of the Sully's Hill area in North Dakota was transferred from the National Park Service to the Department of Agriculture by legislative enactment shortly before the adjournment of Congress. The area, established as a national park in 1904, has never been actively administered by the National Park Service. Although a picturesque forested tract, once the scene of a famous Indian battle, it is lacking in those outstanding natural features of national importance

so essential to national parkhood. For many years the Bureau of Biological Survey of the Department of Agriculture has maintained a game preserve in the area and has financed all improvements made there. The superintendent of the Fort Totten Indian School, through the courtesy of the Bureau of Indian Affairs, has served as acting superintendent of the Sully's Hill Park without cost to the National Park Service.

THE Beit Railway Trust has completed its scheme of fellowships for the two Rhodesias. In order to provide opportunities for young men in Rhodesia to undertake post-graduate studies, the trustees offer three post-graduate fellowships annually tenable for two years at universities, or for special studies at institutions approved by the trustees, in South Africa, Great Britain, the Oversea Dominions, the Continent of Europe, or the United States. The value of a fellowship is £250 per annum, if held in South Africa, and £375 per annum if held oversea. If the course described by a candidate at an approved institution is obtainable in South Africa, preference will be given to that country. Candidates must hold a recognized university degree, be unmarried, and be of European descent through both parents. They must not have passed their twenty-sixth birthday on the date of application and must have resided in Northern or Southern Rhodesia for three full years before the date of application, save that, where a candidate has spent all or part of that period outside Rhodesia in a university or university college, his parents must have resided in Rhodesia for at least five years before the date of application. The administration of the fellowships will be in the hands of an advisory board, of which the chairman will be the Governor of Southern Rhodesia. It is pointed out that out of the funds provided by the will of the late Otto Beit it will now be possible for a boy who begins his education in a Rhodesian primary school to obtain assistance through the secondary school to a South African university and thence to a university or technical institution in Great Britain, the Oversea Dominions, the continent of Europe, or the United States. Sir Alfred Beit has been appointed a Beit Railway Trustee in succession to his father, the late Sir Otto Beit.

THE discovery of element 75, rhenium, was announced by the German chemists, Walter Noddack and Ida Tacke, in 1925. The first actual evidence of its existence was the finding of three or four new lines in x-ray spectra. Through the donation of 1 gram of pure potassium perrhenate to the Bureau of Standards by Dr. A. V. Grosse, of the Institute of Technology, Berlin, a study of the emission spectrum of the new element was made possible. Measurements have now been made by W. F. Meggers at the Bureau of Standards of the arc spectrum of rhenium in the region from 2,300 A in the ultra-violet to 8,800 A in the infra-red. Approximately 2,000 lines have been discovered, all of which are new to the science of spectroscopy, since they are not identifiable with lines emitted by any other known atoms.

THE proceedings of the celebration of the three-hundredth anniversary of the first recognized use of cinchona, held at the Missouri Botanical Garden, October 31 and November 1, 1930, are now ready for distribution. This volume will consist of about 250 pages containing a complete account of the celebration, and will include in addition to scientific papers the dinner speeches by Judge George C. Hitchcock, President, Board of Trustees, Missouri Botanical Garden, presiding; Dr. C. E. Caspari, Dean, St. Louis College of Pharmacy, St. Louis, Missouri; Mr. W. D. Besant, Director of Parks and Botanic Gardens, Glasgow, Scotland; Dr. George D. Rosengarten, Past President of American Chemical Society, Malvern, Pennsylvania, and Dr. A. R. Van Linge, N. V. Nederlandsche Kininefabriek, Maarssen, Netherlands.

The Wistar Institute News reports that owing to the excessive space required in *The Anatomical Record* to print the abstracts of papers presented at the meetings of the American Association of Anatomists and the American Society of Zoologists, the proceedings of these meetings, and the membership lists, it has seemed best to issue four supplements to the *Record* in each year. One supplement would carry the abstracts of papers to be presented at the meetings of the American Society of Zoologists. Another the proceedings and membership list of this society. The third supplement would contain the abstracts of papers to be presented at the meetings of the American Association of Anatomists, and the fourth supplement would contain the proceedings of the meetings and membership list. By this means the publication of original research material will not be delayed.

THE National Forest Reservation Commission on February 25 approved the purchase of 254,022 acres in 19 states, to cost $1,186,159.40, for incorporation into national forests. The commission is composed of Ray Lyman Wilbur, Secretary of the Interior; Arthur M. Hyde, Secretary of Agriculture; Patrick J. Hurley, Secretary of War, chairman; Senators Keyes (Rep.), of New Hampshire, and Harris (Dem.), of Georgia; and Representatives Hawley (Rep.), of Salem, Oreg., and Aswell (Dem.), of Natchitoches, La. Preliminary purchase agreements, including prices, have been made. The lands involved comprise 290 tracts in 26 purchase units or national forests, a purchase unit being a tract designated for purchase for inclusion in a national forest or for establishment of a

new forest. The purchase approved in the Green Mountain unit in Vermont is the first in that unit, which eventually will be a national forest. The commission also discussed establishment of three new purchase units in Wisconsin, but no action was taken on them.

DISCUSSION

ERRONEOUS CITATIONS AND TITLES OF SCIENTIFIC PAPERS

Experiences in connection with the editorial supervision of scientific papers sent in for publication in standard journals, and in connection with the use of literature lists published in other journals, have revealed and emphasized two weaknesses on the part of investigators, which should be considered seriously by every author who attempts to publish an account of his work, and by every editor responsible to the public for the kind of service he renders.

The most discouraging feature of manuscripts, just as they are received from the authors, is the lack of accuracy in citation of pertinent literature, caused by a common failure to check up the citations with the original papers. *It is never safe to copy a citation from some other author's literature list.* Without casting reflections upon any author in particular, I wish to cite a couple specific cases to illustrate this point. Here is a paper by S. S. Zilva, on "The Action of Ultra-Violet Rays on the Accessory Food Factors," published in the Biochem. Jour. **13**: 164–171. 1919. Zilva cites Steenbock, Boutwell and Kent as Jour. Biol. Chem. **36**: 577. 1918. On looking up this citation, I found myself in the midst of a paper by Harden and Young on "Action of Enzymes on Human Placenta." The correct citation for the Steenbock paper is Jour. Biol. Chem. **35**: 517–526. 1918.

Another example may be chosen from the Biochemical Journal, but might be duplicated from any journal. Webster and Hill, in a paper on "The Supposed Influence of Irradiated Air on Growth," Biochem. Jour. **18**: 340–346. 1924, cite Steenbock and Nelson as Jour. Biol. Chem. **61**: 355. 1923. On going to this journal, I found a paper by Petrén on "Low Nitrogen Metabolism with Low Carbohydrate Diet in Diabetes." The Steenbock and Nelson article was finally located in volume **56**: 355–373. 1923, after searching the indices of five volumes.

These are not isolated cases. Everyone who attempts to examine the literature cited in scientific papers will almost immediately run into aggravating difficulties because of the lack of care of authors who are too anxious to publish to take proper time with this indispensable adjunct to a good paper—the literature cited. As an editor with some years of experience in handling publication of papers, I have found it necessary to check up on *all authors.* There is seldom a paper handed in that is free of erroneous citations. In some few cases the citations have been 100 per cent. in error, *even when the author was citing his own work!* To give more concrete quantitative data concerning this evil, a check has been made on a series of papers handled during 1930. The batting average for whole numbers of a publication is approximately 54 per cent. in the cases examined. Forty-six per cent. of the citations needed correction in some way or other. The errors are of numerous kinds, including misspelled names of authors, wrong initials of authors, omission of parts of titles, or substitution of words in titles, change of singular to plural or *vice versa,* omission of umlauts in German titles and of accents in French, failure to capitalize German nouns, capitalization of German adjectives, errors in name of journal, errors in volume number, omission or errors in page limits, error in or omission of year of publication, etc., etc. Every conceivable error that can be made is being made daily by authors, and most of them seem to be utterly unconscious of bad technique in this connection. Or perhaps they think: What's the use of having an editor, if not to do these chores?

Since very few editors take the time and trouble to check up on these errors of citation before publication, the literature lists published during recent years are full of erroneous citations, and it is for this reason that it is never safe to copy a citation from such a list. Nothing but consultation of the original source can insure accuracy, and every author who cites literature should take enough pride in his work to insure accuracy in the literature citations.

The other point of weakness which needs to be considered by authors of papers is the advertising of series of papers through double titles. Turning to a recent literature list in Plant Physiology, we find the following: "Some influences of the development of higher plants upon the microorganisms in the soil. III. Influence of the stage of plant growth upon some activities of the organism." And from the Annals of Botany comes this title: "Observations on the anatomy of teratological seedlings. I. On the anatomy of some polycotylous seedlings of *Cheiranthes cheiri.*" Occasionally authors write in asking to change a perfectly good simple but adequate title to one of these long double titles that require three lines to cite, whereas the simple one requires but one. One wonders why an author should desire these long titles, with constant duplication of the first half. Does he imagine that it is impressive of his prolific authorship

to place XVIII in the midst of a title, and that it would be still more impressive if it reached LXXXVIII? Or will the list of titles not occupy enough space in the 70th year Festschrift unless they are made of double length?

There is surely no good reason for this double title vogue. It is a mischievous habit which should be consistently repressed, not by editors, but by the authors, themselves. Titles should be made as short as they can be made without concealing the nature of the work, in the interests of economy of publication. And every title should be distinct enough to prevent confusion. Occasionally identical titles are used for two different papers. Such papers are easily confused, and wrong citations may be given without authors being aware that they are in error. It is not a difficult matter to select concise and adequate titles of a few words in length. It saves much time in type setting, and much costly space, to make them brief.

As these problems have forced themselves to my attention repeatedly, they are mentioned in the hope that authors who prepare papers for the scientific press will make some effort to cooperate in a difficult situation. Formulation of short titles, and accuracy in citation, would lighten some of the burdens resting upon the publication department of scientific work.

C. A. Shull

The University of Chicago

A FURTHER COMMENT ON THE "PUMPING" HABIT OF PLANT LICE

Had the writer of the article appearing in Science, 72: 560, November 8, 1930, entitled "Plant Lice Pumping in Unison," substituted the word "jumping" for "pumping" he would be more nearly correct in describing the synchronous movements of the members of certain aphid colonies. Instead of the described behavior, which has probably been observed with many species of aphids, on many plants by many entomologists, being explained as one of pumping action it is undoubtedly a response to external stimuli. It is a reaction to danger, to shake off or frighten away the small parasitic flies and wasps attempting to place an egg in or on the aphid's body. With the approach of danger or with slight mechanical stimuli, as jarring, the aphid is disturbed and twitches its body laterally or dorso-ventrally without withdrawing its mouthparts from the plant. The wave of twitching is observed to move along the stem as it is taken up by the other members of the colony. It is not a movement performed simultaneously by all members of the colony.

F. M. Webster and W. J. Phillips, in their treatise on the spring grain aphis (*Toxoptera graminum* Rond.) (U. S. Dept. Agr., Bureau of Entomology Bulletin 110, September, 1912), describe the activity of the parasite *Aphidius testaceipes* Cress. among colonies of this aphid. The parasite is said to show little or no fear while among young nymphs but if she is among a number of adult Toxoptera and they begin to kick up their abdomens, she often hurries away, apparently in alarm (p. 106). An aphid, after being pierced by the ovipositor of this parasite (p. 105) or by that of *Aphelinus nigritus* How. (p. 124), is observed to "kick up" her abdomen as if suffering pain and a droplet of liquid often appears at the point of puncture or at the ends of the cornicles. F. M. Wadley and J. A. Hyslop called attention to the above record on *T. graminum* and also kindly furnished notes on the habits of the following species of aphids. They found that mechanical irritation produced occasional jumping in *T. graminum* but did not observe such a response to similar stimuli among colonies of *Brevicoryne brassicae* L., *Aphis rumicis* L., *Rhopalosiphum prunifoliae* (Fitch), or *Illinoia pisi* (Kalt.). In addition these workers have substantiated the observations of the present writer in several instances where jumping has been noted among individuals in colonies of *Prociphilus imbricator* (Fitch) on beech, *Macrosiphum ambrosiae* (Thomas) on ragweed, *M. rudbeckiae* (Fitch) on golden glow, *M. pelargonii* (Kalt.) on cranesbill, *Aphis illinoiensis* (Shimer) on grape, *Macrosiphonella sanborni* (Gillette) on chrysanthemum, and *Aphis coreopsidis* (Thomas) on cosmos and beggar-tick. *Cerosipha rubifolii* (Thomas) on blackberry, and *Aphis rubicola* Oestlund (*A. rubiphila* Patch), *Amphorophora rubi* (Kalt.), and *A. sensoriata* Mason on raspberry, have not been observed to display this habit. From these observations it appears that this jumping habit is present in species of various habits and of various genera and is rare or absent in other species of the same habits and genera. It is apparently not essential to feeding, since representatives of both groups increase with approximately equal rapidity.

The present writer, in his studies on the feeding habits of certain Homoptera, leafhoppers and aphids, has failed to discern any external evidence of "pumping" of sap by any of the species with their beaks in place. The act of insertion of the mouthparts by an aphid or leafhopper into the plant tissues and the extraction of the plant sap calls into play delicate muscles located within the head. The external evidence of such muscular activity would be quite different from that violent action alluded to in the above mentioned article, from which it might be concluded that the aphid's body functioned as a bulb on an atomizer or hand syringe.

Floyd F. Smith

U. S. Bureau of Entomology

THE DIVINING ROD

I have been much interested by Dr. C. A. Browne's article, "Observations upon the Use of the Divining Rod in Germany," appearing in Science for January 23. It recalls a somewhat similar experience of mine.

For many years a citizen of a neighboring town served this and other communities by using the divining rod to locate supplies of water. In order to settle a friendly argument regarding the existence of this mysterious power, a friend of mine persuaded the dowser to submit himself to a series of tests.

He used forked sticks of any kind of wood, but preferred pear or cherry. His procedure was to walk straight ahead across the chosen field holding the forked stick tilted a little forward, pointing not quite vertically upward. The forks were held in his hands as shown at A, not B, on page 84 of Dr. Browne's article. Presently the stick would bend forward and gradually point downward. Where it was vertical, there a water course existed, the dowser said. A stake was placed there. The process was repeated some distance away, the man walking along a line parallel to the first. Then the line of the water course was determined by walking from one stake to the other following the line where the divining rod continued to point downward. By the same process a second water course was located which intersected the first. The point of intersection was the place to dig the well. He performed this experiment on the college campus in the presence of my friend, myself and a few interested observers.

The usual variations were tried, such as having some one else hold one fork while the dowser held the other, with the usual success. The man was honest, and sincere in his belief that he possessed a mysterious power. He accounted for it by saying that he was very electrical.

Watching his hands during the tests, I soon saw that the bending of the rod was produced by the motion of his right hand. The forearm rotated, bringing the thumb upward and over toward the left hand. The left hand remained stationary. Apparently he was entirely unaware of the fact until it was shown him. When he allowed some one else to hold one fork of the rod, he had always retained the right-hand fork. We then had him retain the left hand fork with one of us holding the right hand one and the rod showed no tendency to bend over.

Other tests were then applied. He was blindfolded and led across the line he had established as showing the water course. Sometimes the divining rod bent over at that line. About as frequently it failed to do that, but bent over at some other place. We had him walk across and then along a blind ditch in which we knew water was flowing. The rod paid no attention to it.

His method of finding lost articles was to put a piece of the same substance at the tip of the rod and then walk about, holding the rod in the same manner as when searching for water. My friend loaned his silver watch for the test. It was concealed in the grass. The dowser stuck a silver quarter in a slit at the end of the rod and began the search. The results were what might be expected. My friend regained his watch later on, but not by that method.

Certain inferences seem well justified. The material of the rod is of no consequence. It serves as an indicator only. The wrist motion of the dowser, apparently involuntary, perhaps even unknown to him, was wholly responsible for the motion of the rod. Can the dowser have some peculiar sensibility which causes that involuntary muscular action when he is near water? In this case, the failure to respond when directly over the ditch where water was then running casts doubt upon that supposition.

The only possibility remaining, so far as I can see, is that one would find water by digging to a sufficient depth almost anywhere. It is quite possible that the percentage of successes in finding water by this method would be quite as large as that obtained by employing a dowser.

Such frequent occurrence of two underground streams of water, intersecting at approximately right angles and continuing as separate streams after intersection, hardly accords with our knowledge of the usual behavior of water. A method which consistently discovers such streams can not fail to arouse skepticism as to the validity of the claims made for it.

Ernest C. Bryant

Middlebury College

THE USE OF THE DIVINING ROD IN GOLD PROSPECTING IN ALASKA

Dr. C. A. Browne's interesting article in Number 1882 of Science, "Observations upon the Use of the Divining Rod in Germany," has brought to my recollection an experience of my own, but in this country.

In 1913 I had a chance to visit Alaska, the purpose of my trip being to familiarize myself with the methods of gold mining as used in Alaska. With introduction cards to local people, given me by my friend, the late Dr. Alfred Brooks, I was able to do more in a few days than otherwise would have been possible in so many weeks. I also enjoyed a most friendly reception by every one with whom I happened to meet during my Alaskan trip. Owing to these facts I had been also able to learn something of the use of the divining rod in Alaska, the use of

which was not widely known, as I found out later in Washington.

My first visit was to the placers a few miles from Nome, operated by one of the most important companies, the exact name of which has slipped my memory. The work was carried on on a rather small scale, and in a few hours the manager of the company had shown me everything that was worth seeing. When we returned to his office, suddenly and to my great surprise and even embarrassment, he said: "Geology and geologists are all right, and they do their best, but in my hunt for gold pockets I have been chiefly dependent on this small instrument." Speaking so, he pulled out from the shelf in the corner of the room a fork-shaped branch of a tree in which I immediately recognized the divining rod of the simplest and most traditional form. Remembering our previous talk with this gentleman, the great respect which he had shown to Dr. Brooks and his collaborators and their geological work, I thought, at first, quite unwillingly, that the manager was trying to have some fun with the foreign geologist. However, I soon realized that he was quite serious. He told me about some tests made with his rod by unbelievers. They had placed a gold coin under the carpet, or pretended that they had, and invited him to locate this coin by means of his rod. If the coin really was under the carpet, the rod would immediately dive, thus showing the position of the coin more or less exactly. The manager was rather modest in his pretensions to find the exact point, but was quite positive that he could locate the coin within a circle of about five feet in diameter. During our talk he held the rod in the traditional way, and suddenly it dived. "I am quite sure," he said, "there is a gold vein under this house, but the trouble is that while by means of this instrument I can discover gold, I am unable to find out how rich the vein would be." Probably this consideration prevented him from tearing down the house to start mining at this particular point. As follows from Dr. Browne's article European operators would be, probably, more successful in this case.

I. P. TOLMACHOFF

CARNEGIE MUSEUM,
PITTSBURGH, PA.

A BANKED RACE-TRACK ILLUSION

WITH the consent of the writer I venture to send the following account of an old experience which I have recently extracted from my friend Mr. Gordon Pennington, a Cleveland engineer.

To keep my promise made this morning, I am going to give you a brief account of my experience on the Luna Park track.

This track, you may recall, was circular, a quarter mile in length, and banked sixty degrees, the banked portion curving gradually to horizontal at the inner edge of the track.

The motorcycles used were light and direct geared and could not be run under thirty-five or forty miles an hour.

When I went out to the track to become a motorcycle racer I had never been on a motorcycle before. On my first experience I rode around the inner edge of the track for several turns at the minimum speed the motorcycle could be held down to. As soon as I became used to this I opened up the throttle, increased my speed and, of course, had to climb up on the sixty degree portion of the track. As I climbed from the more horizontal to the steep portion of the track I was very conscious of the decreasing inclination of my body to the horizontal until, when I had reached the sixty degree section, I had the sensation that my body was almost horizontal (probably was inclined twenty degrees to the horizontal). I was very conscious that I was on my side. I was where I knew I ought to be. My perception was guided by my intellect, not by my internal sensations.

A few seconds after I had reached full speed I experienced the novel sensation I spoke to you about. Suddenly I and my motorcycle seemed to regain the vertical position and, of course, simultaneously the entire track and the field in the center of it, filled with people and automobiles, tilted up at a steep angle. I then found myself racing on a horizontal track (that is, laterally) and at the bottom of a tread mill which seemed to turn under me at just the right speed to keep me always at the bottom.

After my first experience this sensation of being vertical and the rest of the world inclined continued on all subsequent runs, and increased my sense of security on the track. In that first experience, however, when my point of view changed, I was for a few moments completely bewildered, and let my motorcycle travel clear up to the retaining board on the upper edge of the track and very nearly crashed. I suspect that a good proportion of the accidents which have occurred to beginners on these circular tracks have been the result of this moment of bewilderment which I assume that others have experienced in the same way that I did.

When I read this letter to a colleague in the laboratory, one of us said "Gestalt," and spoke of a period of physiological adaptation. The other said "Relativity or Frames of Space" and maintained that the adaptation was purely mental: "It is not like a case of the retina getting modified to function in a different light, or the skin at a different temperature. The otoliths press on the bottom of the rider's labyrinth, his head on his neck, his seat on the saddle, and the wheel itself on the track precisely as they would if the speed of the machine or the curvature of the track were reduced and he were riding practically upright along a flat path."

Both agreed with Mr. Pennington that the "illusion," once accepted, was useful. The one vital problem was to maintain his balance and hold the track, and the more simply and familiarly he could interpret his bodily feelings the easier that was, however topsy-turvy it might seem to make the world beyond. All of which may leave one wondering: When is an illusion not an illusion?

H. AUSTIN AIKINS

WESTERN RESERVE UNIVERSITY

SOCIETIES AND ACADEMIES

NOTES ON THE REPORT FOR ASTRONOMY AT THE CLEVELAND MEETING

IN the reports of the fourth Cleveland meeting of the American Association (SCIENCE for February 6, 1931) the paragraph devoted to Section D (Astronomy) on page 152, for which the present general secretary of the association was responsible, is regrettably inadequate in a number of ways. That paragraph was based on an excellent report received from the section secretary, which was itself too long to be included in the special issue of SCIENCE that carried the story of the meeting. The amount of space actually allotted to any section or society in such an issue can not be ascertained definitely until all manuscripts for that issue have been assembled, after which much deletion is generally necessary. In this instance notes on some important papers were finally omitted and some inaccuracies were introduced. The secretary of Section D has very kindly prepared the following amendations to the report on the Cleveland sessions of that section.

B. E. L.

In the note on the paper by Seares, Sitterly and Joyner, the kernel was omitted with the deletion of mention of "Eros." The investigation was on the magnitudes and color indices of the comparison stars for Eros, and it was in these that they found discrepancies among various observers.

There was but one paper on the Leonids, and that by Morgan and Calvert, who on the morning of the 17th of November, 1930, observed many meteors from the Leonid radiant, at the maximum 187 per hour. The statement of 20,000 meteorites which reach the earth's surface annually was a general estimate by C. C. Wylie and in no way concerned the Leonids.

In the field of spectroscopy, Miss Cecilia Payne presented a study of the Scorpio-Centaurus cluster, in which she emphasized the need of interpretation of the discordances in the character of lines of the spectra, which occur even in stars of the same type. Pressure and stellar rotation were discussed as causes. The important paper by Struve and Elvey on stellar rotation came as an apt sequel to that of Miss Payne. From the contour of the lines they deduce stellar rotation periods and find that equatorial velocities of 250 km/sec are not exceptional. The method was checked by observing the eclipsing variable Algol by the method first used by Schlesinger. Results were in substantial agreement.

Miss Losh finds that the velocity of the center of mass of Zeta Tauri is variable with a period of 24.6 years and a range of 43 km. The possibility of detecting such long-period variations increases as series of observation are extended.

An interesting variation of usual practice in the computation of spectroscopic orbits of eclipsing binaries was suggested by Carpenter, who proposes the introduction of the time of minimum as determined by photometric observation into the computation. A test case of u Herculis yielded gratifying results.

Bobrovnikoff identifies certain nuclear bands in the spectra of comets with the Raffety bands of the presumably CH molecule. The agreement is not complete. Frequency formulae gave fairly good representation for the remainder of the bands with the CN molecule suggested as the carrier. Berman's studies on the nebular lines at wavelengths 3869 and 3967 indicate their intensity ratio approximately constant in various planetary nebulae. Certain considerations lead to the rejection of C^{++} as the source, and the author inquires if P^{++} or Si^{++} are possibly available.

The remaining papers were brief. Alter presented a study by the method of correlation periodograms of the planetary tidal hypothesis and variation of sun-spot activity. Extension into the future will test the validity of the conclusions, which seem decidedly interesting. Joseph Johnson gave a preliminary report on the solar eclipse of 21 October 1930 as observed at Niuafou. His attention was especially directed to determination of the intensity of various parts of the corona. MacMillan showed some ingenious stereoscopic pictures of star clusters. Mees discussed the characteristics of some new high-speed panchromatic plates developed by Eastman Kodak Company, adaptable to visual refractors. Mehlin gave the result of the test of the objective of the Drake Municipal Observatory, and Dustheimer reviewed the astronomical radio program of WTAM. This station has broadcast 62 astronomical talks in the last six years.

It is expected that the paper on the "Life of Sir Isaac Newton, a Character Sketch," by Louis T.

More, presented at the joint session with Section L and the History of Science Society, will be published in full by the History of Science Society. Failure to mention this carefully prepared paper is the last serious omission.

P. F.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF MAKING TOPOGRAPHIC MODELS

RELIEF models have recognized advantages over other devices for representing topography. Teachers of physical geography, physiography or geography have found them especially valuable. Models of this type can be readily understood by children as well as by adults; hence their usefulness extends through the entire range of age groups.

One serious limitation in the use of such models is the difficulty of achieving detail and accuracy without spending an undue amount of time in their construction. To overcome these difficulties in part, a device was developed by the writer at Syracuse University when it was desired to prepare a model of the local area for the Natural Science Museum. With the aid of this device, nearly four thousand five hundred square miles of topography, representing central New York, have been completed. Both the accuracy and the amount of detail have proved satisfactory. Since the work was done during spare time, no accurate records were kept of the number of hours required. A fair estimate is that twenty-five square miles of topography of average difficulty may be completed in one hour, after a little experience.

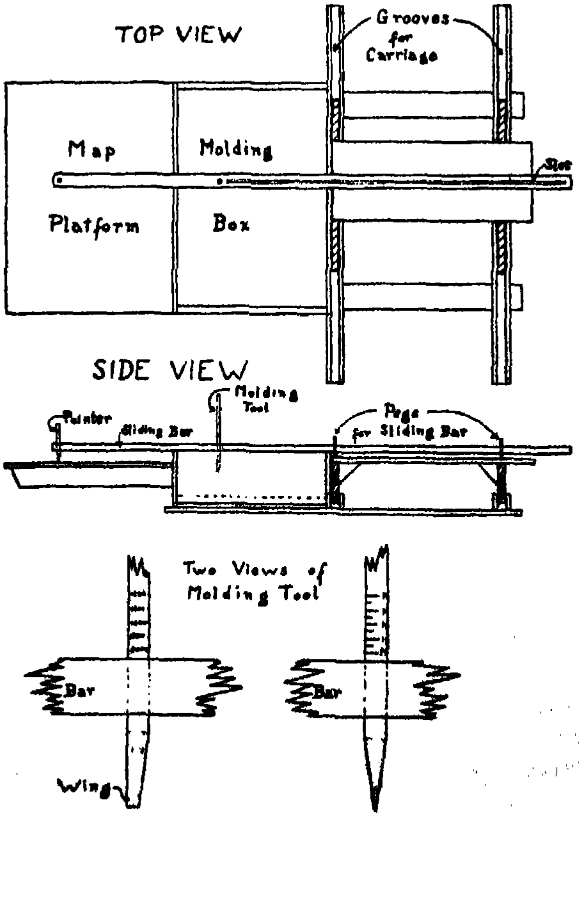
The method consists in making the relief first in molding sand, using a contour map as a guide. Plaster of Paris is then poured over the sand model, and the resulting plate used as a mold from which the permanent model, also of plaster, is cast.

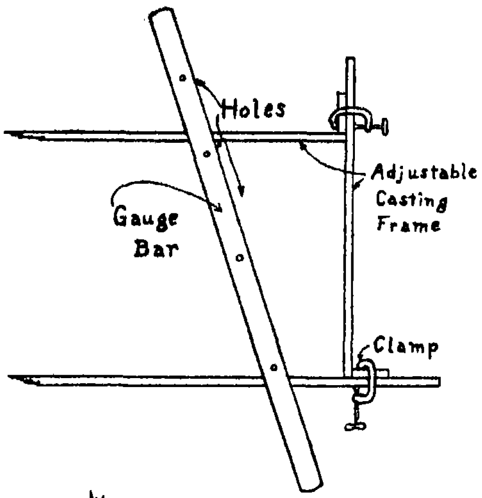
The central unit of the device for making the sand model consists of a box slightly longer and wider than the map, and about two inches deeper than is required for the maximum relief in the area to be represented. This box carries an attached platform at the left hand side on which the map is placed. A sliding carriage is mounted in grooves on the right hand side, free to move forward or backward as far as the limits of the box, but fitting closely in the grooves. This carriage supports a sliding bar which may be moved from side to side. The bar carries a molding tool near its center and a pointer at the left hand end by means of which map locations are transferred to the sand box. The vertical scale is marked on the molding tool. To facilitate the removal of the plaster plate from the sand box, the latter is provided with a false bottom which is lifted out by means of wires attached near each corner.

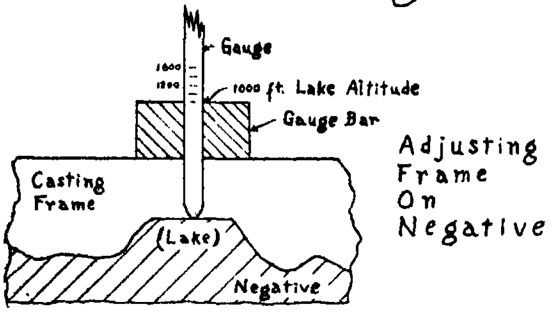
Much of the effectiveness of a relief model depends on a proper vertical scale. The vertical exaggeration employed on the Syracuse model is approximately 4 1/3. That is, with a horizontal scale from the map of 1/62500, the vertical scale is twelve hundred feet to the inch. This is enough to accentuate the low relief of the Ontario Plain north of Syracuse, and yet not too much for the dissected plateau country to the south.

Procedure: Fill the box nearly full of fine moist molding sand, tamped down firmly. Adjust the map so that when the pointer is moved around the map margin the molding tool will follow around the inside margin of the box. Secure the map in position with thumb tacks.

It has been found best to begin with that portion of the map nearest the operator. Place the pointer successively at each prominent hill top and set the tool each time at the corresponding level. Hold the tool and bar with the left hand, and grasp the carriage with the right. By moving the bar from side to side, and the carriage forward and backward, the excess sand is loosened and may be removed. A teaspoon and a soft brush have been found satisfactory for this purpose. Then select a contour line about a







hundred feet lower and set the tool to throw the sand away from the hill as the pointer follows along the line. It may be necessary to turn the tool as the direction of the line changes. Much care is required to avoid breaking down steep hillsides or narrow ridges. Experience will develop the proper technique. The minor ravines are best done free hand, using either the spoon or the molding tool after determining accurately their positions. If the sand becomes dry and crumbles it must be moistened by careful sprinkling. When the model has been formed, the loose sand grains at the surface should be pressed down with the fingers, being careful not to destroy any part of the work, or to leave concave finger imprints. A thin mixture of plaster of Paris may now be poured gently over the model to a depth of about an inch, or until the hill tops are well covered. The amount necessary will be governed to some extent by the nature of the relief. When it has set firmly it should be loosened from the sides of the box and removed by lifting out the false bottom. The sand may now be cleaned from it by scraping and brushing.

The final cast is made in an adjustable frame. The one used by the writer consists of four separate side pieces, each with a flange at one end by which they are clamped to each other with small clamps. This frame fits closely around the plate or negative, and is supported independently. A gauge is used to adjust the height of the frame. Test the adjustment by sighting across the edges. They must all be in the same plane else the completed cast will not rest on an even base. The surface of the mold must be coated with vaseline or similar substance to prevent the cast from sticking. Fill the frame with plaster of Paris mixed thin enough to fill readily the inequalities of the mold. Use a straight-edged board to smooth the top even with the edges of the frame. Oftentimes it will not be necessary to fill the center of the frame to this level. Use only enough plaster to insure adequate thickness and strength. When dry, the cast may be cleaned and painted in any desired manner.

An important feature of this device is that the completed model has the same horizontal scale as the map from which it is taken. If a pantograph is used to guide the molding tool, the model may be made either larger or smaller than the map, but it is not convenient to reproduce the same scale. The writer has used a large pantograph in this way to increase the scale of models made from maps. It is a satisfactory method, except that the enlarged model calls for a corresponding increase in detail not shown by the map.

CHAUNCEY D. HOLMES
SYRACUSE UNIVERSITY

AN OSCILLATOR AND SYNCHRONOUS MOTOR FOR OBTAINING EXACT VARIABLE SPEEDS

WHERE it is desired to have a shaft or disc rotating at a single exact rate, the synchronous motor, following the oscillations of an alternating current, gives an extremely high degree of accuracy. The type of motor employed in electric clocks and that recently described by Wilkins[1] serve that purpose. However, it is often necessary to have the rate of rotation exact, but capable of rapid and convenient variation. The clock motor, though designed to operate on 60 cycle alternating current, can be made to run and vary its speed over a fairly wide range if operated from the output of an oscillator of variable frequency.

The construction of such an oscillator is shown in Fig. 1. A screen grid tube, Type UX-222, is employed as a dynatron in a circuit of the parallel tuned type. This kind of oscillating circuit has the advantage of stability greater than that afforded by the ordinary type of vacuum tube oscillator.[2] If the proper capacities and inductances are used variation of frequency over a wide range is possible. Small inductance, capacity, or both, yield high frequency; lower frequencies are obtainable by the use of larger

[1] H. S. Wilkins, *Gen. Rad. Experimenter*, 1930, 5, No. 5, 3–7.

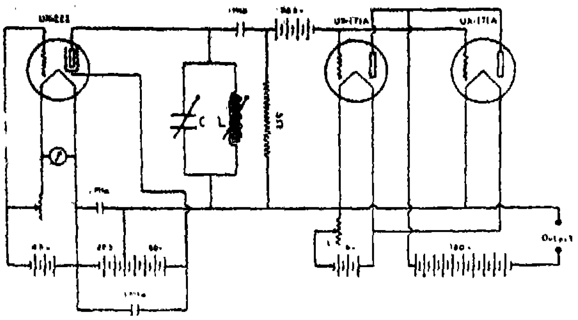


FIG. 1.

inductances and capacities. The frequency in cycles per second is approximately given by the relation: $f = \frac{1}{2\pi\sqrt{LC}}$ where L is the inductance in henries and C is the capacity in farads. A convenient arrangement, if not too great variations of frequency are desired, is one using a constant inductance such as that supplied by the primary of an audio-frequency transformer and variable capacity supplied by a battery of fixed and variable condensers joined in parallel by appropriate keys. A gross change in range may be effected by tapping the inductance or increasing the original amount. If greater accuracy is desired a coil of three or four henries may be wound and substituted for the transformer. Since the frequency of the oscillating circuit is not independent of the voltage supplied to the filament of the screen grid tube it is well to insert a voltmeter in the filament circuit. Maximum efficiency is achieved by operating the filament at the rated 3.3 volts.

The power to run the clock motor is secured from a series of UX-171A tubes in parallel, two being sufficient to take care of small motor loads. Most synchronous clock motors draw about 2 watts; this makes possible the use of dry cell batteries as sources of power. The A and B voltages of the power stage and oscillator have been taken from separate sources, though this is doubtless an unnecessary refinement. With the usual modifications of the circuit, operation would probably be quite satisfactory with A.C. for filament voltage and rectified A.C. for B and C supply. In order to operate the clock motor it is necessary to allow the D.C. as well as the A.C. output of the tubes to flow through the stator windings.

As is necessary in the operation of all synchronous motors, the clock motor is started by spinning the shaft until the motor falls into synchronism at either of two fractions of the impressed frequency, the one being twice the other. These are not difficult to discriminate, since they depend upon the starting torque. In our arrangement the primary shaft has been made to turn at speeds varying from 250 to above 700 r.p.m. without running at multiples. A greater range would be entirely possible, though this is sufficient for most purposes, since gross changes may be effected by gearing the shaft up or down.

Calibration of the oscillator is best effected by substituting an electric clock for the motor in the output circuit. If this is allowed to run ten minutes, for example, with the oscillator at one setting and its rate of motion, as indicated by the hands, be compared with that of an ordinary timepiece, the frequency of the oscillator can be computed with great accuracy.

The apparatus described was developed for use in an experiment on the critical frequency of flicker, where the speed of rotation of a sectored disc must be changed by exactly known amounts. Other uses are apparent. As just described, the method is an excellent one for determining frequency. The rotating disc could be supplied with a contact to interrupt a circuit at definitely variable intervals. The frequency of a second oscillator could be calibrated over a range much higher than the first by connecting the second oscillator to a neon bulb and making it produce a stroboscopic pattern on a disc rotated by the first.

ROLAND C. DAVIS
FRANK A. GELDARD
PSYCHOLOGICAL LABORATORY,
UNIVERSITY OF VIRGINIA

SPECIAL ARTICLES

A FLOWERING CYCADEOID FROM THE ISLE OF WIGHT

FOLLOWING the notes on the petrified "cycad" trunks of the Isle of Portland given by Dr. Buckland with the advice of the famous botanist, Robert Brown, a hundred years ago, the definitive knowledge of the cycadeoids or flowering cycads begins with Carruthers' description of *"Bennettites Gibsonianus"* from Luccomb Chine on the southeast shore of the Isle of Wight, in 1870. Just when these stem-bearing mature cones were first seen is not so sure. In Wilkins' "Geology and Antiquities of the Isle of Wight" of 1859, there is mentioned as coming from Sandown (a Wealden shore), "an interesting specimen in a nodule with a fracture across it, exposing its fructification with seed vessels, discovered by my friend T. F. Gibson Esq." This is likely the Carruthers type, despite any discrepancy as to locality or horizon;

[3] C. E. Worthen, *Gen. Rad. Experimenter*, 1930, 4, No. 12, 1–4.

although such a specimen does not seem to have been seen as early as the year 1850. Then Robert Brown had remarked that so far as known to him "all the cycad stems from the Isle of Wight differed from those of the Isle of Portland in having a bud in the axilla of each leaf."

Cycadeous stems with a full complement of axillary structures such as Brown seems to have seen are not clearly in evidence in the recorded material from the shores of the Isle of Wight, whether from either the Wealden or the Greensand. Nor have any such since appeared at the Isle of Portland. Albeit, the Chine at Luccomb must ever remain the classic locality of unusual stems, as again proven by a fortunate long hoped for supplementary *find* made by Alfred J. Mew, Esq., of Shanklin, I. W. The "chines" (from the old French and Anglo-Saxon, meaning a cut), are those deep, rugged and picturesque gorges cut back from the shore into either end of the "Undercliffe," a remarkable talus of yet higher rocks stretching along the south shore of the Island for some miles. The Luccomb chine is the first to the east of the Undercliffe, and there, on the beach at the right entrance wall, Mr. Mew made his find about seventeen years ago.

Mr. Mew as a lover of science had long held the very laudable desire of seeing a compact museum unit in his town of Shanklin. But this project seeming to fail of realization, his Luccomb specimen with other material remained by the side until recently. Then, on the occasion of my visit to the Isle of Wight following attendance at the recent International Botanical Congress at Cambridge, through a cordial introduction from a neighbor, Mr. H. F. Poole, after some discussion the suggestion was made and followed to turn the fine specimen over to the Yale collections. Both these gentlemen were fully aware of its interest and promise as one of the handsomest single gifts ever made to Yale. Mr. Poole had also made an important find of a fragment of a trunk still remaining *in situ* in the lower Greensand at a point near by, and about four feet above high tide.

The Mew cycad reached Yale safely, and I have sawn through it longitudinally and transversely, with some lesser cutting, and the smoothing down of the significant tangent surfaces as well, bringing to view the main vegetative and reproductive features in an essential completeness. The stem is a medium sized one bearing its fructifications sparsely, for about the first time. It is 25 cm high by 24 cm on the flat, and 17 cm through on the compressed diameter. The form is distinctly pear-shape due to the thick mass of old frond bases above, amongst which are imbedded young ovulate, and several staminate flower-buds, and at the summit in armor and ramentum 8 to 9 cm deep a splendid crown of fifteen well grown and but slightly emergent young fronds revealing in the transverse section the full pinnule series and structure. The medulla is 10 cm in diameter, the wood and cortex thin. As a specimen this is hence a virtually perfect one, and being quite uneroded it must have been found by Mr. Mew very shortly after rolling down from its matrix onto the upper beach. It even carries on one side a large patch of the lower Greensand rock which, taken with Mr. Poole's *in situ* find, settles at last the position of the most important cycad horizon of the Greensand.

Calcite is the main petrifying material in these petrifactions of the Greensand as more or less associated with stems of conifers. Here and there, though chiefly in the outer armor, are pyritized patches with residual plant carbon. In addition there are in places numerous small pyrite crystals which easily tear out and scratch the surfaces in course of preparation for closer study. There is little direct evidence of siliceous content. But just as some of the darker carbon-containing silicified cycads like *Raumeria* may be etched by hydrofluoric acid and studied by the Walton gelatine-pull method, so here hydrochloric acid is effective. Also, coloration is such as to yield much detail and fine photographs on all smoothed surfaces. Whether the stem is to be referred specifically to *Cycadeoidea* (Bennettites) *Gibsonianus* is not yet quite certain, but probably it is so referable.

This is the first instance of a European cycad bearing a full crown of fronds comparable to those seen in various American specimens. Small fronds found on a very tiny trunk or branch of indeterminate locality yielded to Dr. Stopes excellent histologic details. Also I found on an Isle of Portland *Cycadeoidea microphylla* very young fronds with the bundle series alone indicated. These three instances are thus the only ones in which the fronds have been seen at all in the European petrified series. Therefore, with the three European and six American species of *Cycadeoidea* in which leaves occur, there are in the world nine known species with foliage. All agree in the presence of a varyingly dense mat of hairs borne not alone on the rachis but all over the under surface of the pinnules as first noted by Dr. Stopes, and overlooked by me in the initial instances studied.

The ovulate cones of the Mew cycad, of which there may be a half dozen, are about a scant half centimeter in diameter, by a centimeter long and very prettily calcified. Of the complete flowerbuds two are fairly seen; but as the petalo-staminate disk is much pyritized the features are not so fully preserved as in *Raumeria* and the American specimens. No less, they are unmistakable. The disk includes eight

staminate fronds, the lowest number thus far seen in cycadeoids; and it is so furrowed on its outer side as to indicate the probable number of the fused petals to be sixteen. The disk diameters are 9 and 19 mm due to compression. Inside the disk the medium-sized synangia are here and there nicely indicated by their outer palisade layer as seen even under a hand lens on smoothed surfaces. This is therefore the second European specimen in which the complete flowers are seen, the third with the preserved synangia. Those I found in *Cycadeoidea etrusca*, though overlooked by Capellini and Solms, were the first, those of *Raumeria* the second recorded.

The foregoing features emphasize the fact that the Mew cycad must rank as the fourth finest European specimen yet discovered, even if it does not stand alone. The record begins with the Dresden *Raumeria*, found or first noted in 1753. This stem bears the large specialized flowers with sixteen stamens like those of the Black Hills, but is held distinct generically because of the wood structure. The second great specimen is the *Cycadeoidea* (Bennettites) *Gibsonianus*, found as noted above about 1850, and twenty years later in the hands of William Carruthers revealing a seed cone organization strangely and unexpectedly different from that of all previously known cycads or other gymnosperms existent or extinct. The third is the *Cycadeoidea etrusca* of the necropolis and nearby Etruscan temple of 4,300 years ago at Marzabotto, and thus the oldest petrifaction of record ever handled by man. Refound in 1878, this stem yielded the first young seed cones with associated pollen grains, indicating the possibility of an amphisporangiate fructification; although Capellini and Solms overlooked the presence of the distinctly chalcedonized synangia, as I found on later examination of the type at Bologna. As the fourth of the European series showing the critical structures, the Mew cycad is therefore the equal of any, in fact the most complete of all in what it shows. As in the great *Cycadeoidea ingens* of the Black Hills, the first event in its fossilization occurred in the springtime. As in the magnolias the flowers appeared early, and then the fronds; although the sparse flowers and cones of this rather young stem seem once more to indicate the presence of monecism in the cycadeoids, rather than the uniformly complete floral type. These features need closer scanning. But as so well recognized the general organization had long departed from the ancient lines, and was specialized in its own way in form and foliage, especially in the increased size and diminished number of the flowers.

The next great find of the Isle of Wight collector, whether in the Greensand or at the "log raft" in the Wealden at Brook (= Como), must be one of those trunks bearing floral buds in all the axillae of the fronds, as seen by Robert Brown. Such, since the assemblage of the splendid series of trunks from the Navajo Country with their full complement of small flowers, must be regarded as the more primitive cycadeoid type.

The aid that has been given from European and other sources in the freest use of priceless and historic specimens of the petrified cycadeoids for comparison in the study of the American material has had a profound meaning and value. It has come in the first instances from Capellini at Bologna, Lignier at Caen, the custodians of the Zwinger Museum at Dresden, and from Britain. It proves that in the foremost countries the collector and the student is free in laboratory and field, and unhampered by legal or other restrictions; while fossil botany is to its devotees a world subject. It shows that eventually some concerted plan must be adopted making the unrivaled American cycadeoid collections a source of material for direct university use and demonstration *per se* of these, the most singular and instructive of all extinct flowering gymnosperms.

G. R. Wieland

Carnegie Institution,
Yale University

THE NEURO-MUSCULAR MECHANISM CONTROLLING FLASHING IN THE LAMPYRID FIREFLIES

By the use of a photoelectric cell and amplifier in connection with the string galvanometer,[1] it has been possible to record curves of the flashes of *Photuris Pennsylvanica*. Records of spontaneous flashes and records of electrically stimulated flashes were obtained under normal conditions, under various oxygen tensions, and under various conditions of pressure and other factors. Fig. 1 is an illustration of the curve from a typical normal spontaneous flash.

Analysis of the curves of normal flashes shows that there are two independent mechanisms governing the amount of light in any flash. One is evident through a factor, which, when it varies, affects only the height of the intensity-time curve; it does not affect the ratio of the development and decay portions of the curve, and does not affect the duration of the flash. The other factor affects primarily the duration of the flash; it also affects the height and to some extent the relationships of the development and decay portions of the curve. These findings lend support to the observation, made first by Lund,[2] that either few or many discrete and definite individual areas of a luminous organ may be involved in any flash. The

[1] E. N. Harvey and P. A. Snell, Proc. Amer. Philos. Soc., 69, 303, 1930; *J. Gen. Physiol.*, March, 1931.
[2] E. J. Lund, *J. Exp. Zool.*, 11, 415, 1911.

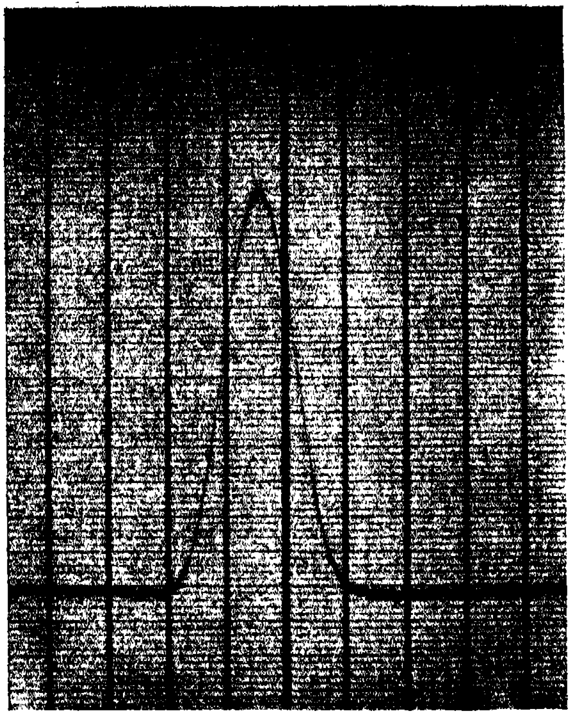


FIG. 1. Normal Spontaneous Flash. Unmounted ♂. Vertical lines indicate .04 second.

factor affecting the height of the curves but not the duration is the *expression of the number of units* of the luminous organ in action in that flash; the factor affecting primarily the duration is an expression of the activity of the controlling mechanism of these individual areas.

The normal flash shows a large range of intensity due to the two variable factors just described. The duration range is on the contrary comparatively narrow, with very few exceptions lying outside this range which are probably not normal flashes; the duration varies between 0.09 and 0.16 second, with the majority about 0.12 second.

It was found that all the characteristics of a spontaneous flash could be duplicated by the flash of a specimen from which the head and thorax had been dissected, when the abdomen remaining was stimulated in certain ways by singly induced shocks. The strength of current necessary to produce stimulation of all parts of the luminous organ produces injury to the specimen, and these preparations could therefore not be used for experiments requiring a series of observations and records. The analogy of such a preparation with the well-known nerve-muscle preparation is striking. The intensity-duration curve of the flash is similar in nature to the height-duration curve of a muscle contraction.

Reducing the pressure and oxygen tension by vacuum has the same qualitative and quantitative effect on the flash as reducing the tension only by means of oxygen-nitrogen gas mixtures. Normal flashing will take place in oxygen tensions above 20 mm of mercury. Below this point the controlling mechanism is rapidly injured so that it ceases to function, luminescence becomes continuous, and its intensity varies with the oxygen tension. Complete functional recovery takes place if the low oxygen tension is not maintained too long.

These experiments indicate that the mechanism controlling the flashing is responsive to nervous and to direct electrical stimulation, that it effects the control by regulating the admission of oxygen to the cells containing the photogenic substances, and that variation in the character of the flash is brought about by variation either of the number of units stimulated or of the amount of stimulation and response (admission of oxygen to the cells) in the unit involved. The tracheal end cell, which has for a long time been considered by histological investigators to be responsible for the control of luminescence,[3] is certainly the responsive mechanism in this control. Its anatomical features, together with these physiological observations, lead directly to this conclusion.

This work is part of a program of studies on bioluminescence carried out under the direction of Professor E. N. Harvey in the Physiological Laboratory, Princeton, New Jersey.

PETER A. SNELL

ROCHESTER, NEW YORK

SOME OBSERVATIONS ON THE CORTICO-ADRENAL HORMONE

IN a recent short article[1] it was shown that extracts of the adrenal cortex prepared in this laboratory according to the method of Swingle and Pfiffner[2] were remarkably effective in maintaining adrenalectomized cats in apparently normal health and in abolishing the severe symptoms of adrenal insufficiency. Confirmation was given, therefore, of the observations of the Princeton investigators.

To avoid the considerable labor of scraping out the medulla, we have used whole adrenal glands in making our extracts. At the abattoir the glands are exsected from the still warm carcasses and immediately frozen. Shipment is made to the laboratory in carbon dioxide snow, and the glands are finely ground while still in a frozen state and placed in 95 per cent. ethyl alcohol. In the process of preparation of the cortico-adrenal extract, the adrenalin originally present in the whole glands seems to a large extent to disappear. Only traces of adrenalin are left in the crude extract, the

[3] U. Dahlgren, *J. Franklin Inst.*, 1917.

[1] S. W. Britton and Herbert Silvette, SCIENCE, 73: p. 322, March 20, 1931.

[2] W. W. Swingle and J. J. Pfiffner, *Amer. J. Physiol.*, 96: 153, 1931.

rest having been either destroyed by inadvertent oxidation or differentially partitioned between the various organic solvents employed. These traces may be readily removed by a small quantity of permutit—we use 30 grams per 5 kilos of glands—so that the final extract made from the whole glands contains less than 1:2,000,000 parts of adrenalin when tested by the blood pressure or intestinal strip methods. Our extracts are made up to a final concentration of 40 grams of whole glands per cubic centimeter. We have prepared extracts for the past six months according to these modifications of the Swingle-Pfiffner technique, and the product is apparently as potent as any which has yet been reported.

Besides the general restorative effects on comatose adrenalectomized animals, which have previously been described, the cortico-adrenal extract produces significant changes in carbohydrate metabolism. For a period of several hours following injection of the hormone, the percentage of sugar in the blood gradually rises from the convulsive level to normal limits, or even higher. In a series of twenty cases this result has been consistently observed. Normal cats and rats also show slowly rising blood-sugar levels following administration of the extract. In man the material is apparently without effect on the blood sugar in small doses of one or two cubic centimeters; a larger dose—15 cc injected intramuscularly in a subject under basal conditions—produced a gradual rise from 90 to 115 milligrams in 4½ hours.

It should be emphasized that the above glycemic changes are not at all referable to adrenalin action. When injected in similar dilution and amount to that present in the cortical extracts—between 1:2,000,000 and 1:4,000,000 parts of adrenalin, in amounts up to 10 cc per kilo—adrenalin produces only a slight increase in the blood sugar, and a fall to the normal level occurs within an hour or so after the injection. The gradual augmentation of the blood-sugar level following injection of the cortico-adrenal extract, reaching a maximum six or eight hours after the injection, is in marked contrast to the effect of the medullary hormone. Also in contrast to the action of the cortico-adrenal hormone is the merely temporary effect of adrenalin in resuscitating prostrated adrenalectomized animals.

The hypoglycemic and convulsive reactions following insulin administration appear to be scarcely affected, even when large doses of the extract are given intraperitoneally or intracardially. When the material is given as a preliminary measure, an hour or so before the administration of insulin, the action of the latter also appears to be relatively unaffected. In this respect the well-known effect of adrenalin in alleviating the severe symptoms of insulin intoxication finds no parallel in the action of the new cortico-adrenal hormone.

The effect of the cortico-adrenal hormone on carbohydrate metabolism is apparently quantitative in nature. Although different lots of extract differ in potency, and the experimental animals vary in their resistance or susceptibility to the material, experiments performed at various times with a particular extract on the same animal indicate very clearly this quantitative effect. An injection of 10 cc per kilo causes approximately twice the percentage rise in blood sugar, as does one of 5 cc per kilo. In general, it may be said that the blood-sugar raising power of the hormone is a direct function of the amount of the substance injected and also of the elapsed time.

Numerous observers[3] have reported that the percentage of the non-protein nitrogen in the blood becomes remarkably elevated following removal of both adrenals. Hartman *et al.*[4] have recently observed that their cortical extract brings about a reduction in the blood urea of adrenalectomized cats. The high levels of blood non-protein nitrogen which we have observed in a large series of animals are, however, only slightly affected by large doses of the cortico-adrenal extract prepared according to the Swingle-Pfiffner method. The profound anhydremia which is observed in animals following adrenal extirpation, and the extensive circulatory changes which are brought about following injection of the cortico-adrenal extract must, however, be given careful consideration in connection with the observed changes in the carbohydrate and nitrogenous constituents of the blood.

Further blood changes and circulatory effects which we have observed to be produced by the extract, and also the influence of the hormone on body temperature, will be reported upon later.

S. W. BRITTON
HERBERT SILVETTE[5]

PHYSIOLOGICAL LABORATORY,
UNIVERSITY OF VIRGINIA

BOOKS RECEIVED

EDGE, W. L. *The Theory of Ruled Surfaces.* Pp. viii + 324. Cambridge University Press, Macmillan. $7.00.

MORSE, WILLIAM C. *Paleozoic Rocks.* Bulletin No. 23. Pp. xi + 212. 15 figures and 23 plates. Mississippi State Geological Survey.

SMART, W. M. *Text-Book on Spherical Astronomy.* Pp. xi + 414. 146 figures. Cambridge University Press, Macmillan. $7.00.

[3] S. W. Britton, *Physiol. Review*, 10: 617, 1930.

[4] F. A. Hartman, K. A. Brownell and W. E. Hartman, *Amer. J. Physiol.*, 95: 670, 1930.

[5] Porter fellow in physiology.

Grateful acknowledgment is made of aid in the above investigations by the Committee on Grants-in-Aid of the National Research Council.

SCIENCE

VOL. 73 FRIDAY, APRIL 10, 1931 No. 1893

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

PROFESSOR EINSTEIN AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

ADDRESSES AT THE DINNER IN HIS HONOR[1]

MR. ALLAN C. BALCH, PRESIDENT OF THE ATHENAEUM:

THIS is a dinner of some two hundred California Institute Associates, held at the Athenaeum, a building designed as a club house and meeting center for three groups of people: First, the staffs of the three adjacent cooperating institutions, the California Institute of Technology, the Mount Wilson Observatory of the Carnegie Institution of Washington and the Henry E. Huntington Library and Art Gallery; second, eastern and foreign scholars who are drawn to this research and educational center for participation in, or some sort of association with, its activities; third, the group of residents of this Southern California community known as the California Institute Associates, who are interested in and promotors of the scientific and scholarly work going on in these institutions.

I wish to call first on Russell H. Ballard, president of the Southern California Edison Company and president, also, of the California Institute Associates.

MR. BALLARD:

Mr. Balch, Professor Einstein and the California Institute Associates:

It is rare good fortune that there is at this moment a conjunction here at the Athenaeum of a large number of the men who have worked as colaborers in the development of those phases of modern knowledge and modern thought to which the guest of honor tonight has made far-reaching contributions. I am going to call the roll, in the order of seniority, of this group of Einstein collaborators here present:

Albert A. Michelson, emeritus director of the Ryer-

[1] The Athenaeum, California Institute of Technology, January 15, 1931.

son Physical Laboratory of the University of Chicago, now a permanent resident of Pasadena and an associate of both the California Institute and the Mount Wilson Observatory; Charles E. St. John, astrophysicist of the Mount Wilson Observatory; William Wallace Campbell, president emeritus of the University of California and formerly director of the Lick Observatory; Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute; Albert Einstein, professor of theoretical physics of the University of Berlin; Walter S. Adams, director of the Mount Wilson Observatory; Richard C. Tolman, professor of physical chemistry and theoretical physics of the California Institute; Edwin P. Hubble, astrophysicist of the Mount Wilson Observatory.

This is just the sort of meeting the California Institute Associates will participate in, we hope, each year, and a number of times each year, throughout all the coming years, and I welcome you all to this first meeting of this sort in this new and extraordinarily beautiful Athenaeum.

MR. BALCH:

I now wish to call on Robert A. Millikan to act as toastmaster in the introduction of the scientific speakers.

DR. MILLIKAN:

The distinguishing feature of modern scientific thought lies in the fact that it begins by discarding all *a priori* conceptions about the nature of reality—or about the ultimate nature of the universe—such as had characterized practically all Greek philosophy and all medieval thinking as well, and takes instead, as its starting point, well-authenticated, carefully tested experimental facts, no matter whether these facts seem at the moment to fit into any general philosophical scheme or not—that is, no matter whether they seem at the moment to be reasonable or not. In a word, modern science is essentially empirical, and no one has done more to make it so than the theoretical physicist, Albert Einstein. That, in a sentence, is, I take it, his greatest contribution to modern thought. It will stand out repeatedly in all that is said to-night.

Throughout the nineteenth century we had been building up what seemed a wonderfully consistent "natural philosophy" as to the nature of radiant energy—a beautiful wave-theory of light. Professor Michelson's own researches on interference had furnished some of its strongest supports. This theory required that it be possible, by noting the difference in time required for a beam of light to get back to the observer when, on the one hand, it was sent forth in the direction of the earth's motion and back by reflection from a mirror to the observer, and when, on the other hand, it was sent a like distance forth and back at right angles to the earth's motion, to find the speed with which the earth is moving through the ether. But this experiment, when first performed with extraordinary skill and refinement by Michelson and Morley in 1887, yielded with great definiteness the answer that there is no such time-difference and therefore no observable velocity of the earth with respect to the ether. That unreasonable, apparently inexplicable experimental fact has now been checked by a multitude of observers—very recently and very carefully by Michelson himself, and also in extraordinarily exact measurements by Roy J. Kennedy at the California Institute, so that it is now a well-authenticated fact.

For twenty years after this fact came to light physicists wandered in the wilderness in the disheartening effort to make it seem reasonable. Then Einstein called out to us all, "Let us merely accept this as an established experimental fact and proceed to work out its inevitable consequences," and he went at that task himself with an energy and a capacity which very few people on earth possess. Thus was born the special theory of relativity, and I now wish to introduce the man who laid its experimental foundations, Professor Albert A. Michelson, my own chief and my adviser and friend for twenty-five years at the University of Chicago, the man who gave me my own opportunity in physics, and by his own example—the greatest of stimulants—showed me how to use it.

DR. MICHELSON:

I very highly appreciate this opportunity of greeting Dr. and Mrs. Einstein and welcoming them to our institute. We consider it one of the highest honors and trust that the stay of our guest of honor may be so delightful that he will take frequent opportunities of repeating the experience. I consider it particularly fortunate for myself to be able to express to Dr. Einstein my appreciation of the honor and distinction he has conferred upon me for the result which he so generously attributes to the experiments made half a century ago in connection with Professor Morley, and which he is so generous as to acknowledge as being a contribution on the experimental side which led to his famous theory of relativity. I may recall the fact that in making this experiment there was no conception of the tremendous consequences brought about by the great revolution which Dr. Einstein's theory of relativity has caused—a revolution in scientific thought unprecedented in the history of science.

In concluding, may I be permitted to congratulate

the trio, the California Institute of Technology, the Mount Wilson Observatory and the Huntington Library, and especially Dr. George E. Hale, whose influence brought about the realization of this dream. May it continue to prove the attraction which it has shown in bringing to these delightful precincts these celebrated men culminating in the presence of our distinguished guest.

DR. MILLIKAN:

You and I are not interested, nor should we be expected to be interested, in just how Professor Einstein worked out the consequences of his assumption that it is impossible to detect the motion of the earth with respect to space, nor indeed in what additional postulates he had to make to round out the theory and make it more general so that it might cover not only predictions on the relations of bodies moving with constant relative velocities, but also predictions in cases in which rates of change of velocities, or accelerations, were involved. These are technical matters which we should no more expect to be able to follow into their details than we should expect to be able to follow the steps by which an astronomer computes the orbit of a planet, or an assayist analyzes a sample of ore. What we do wish to know, however, is simply this: Does the computation or the analysis yield results which can be experimentally verified? Professor Einstein himself has repeatedly assured us that his work must stand or fall by that test alone. I wish, therefore, to introduce to you now William Wallace Campbell, one of the group of experimental astronomers who has himself made one of the accurate tests of Einstein's predictions, and I am herewith assigning to him the task of sketching the development of the experimental credentials of the general theory of relativity.

DR. CAMPBELL:

When Professor Einstein published his immortal theory of relativity, a theory evolved within the four walls of his study room, he in effect advised his colleagues in the world of science to delay their acceptance of it until after it had been subjected to certain observational tests. He described three such tests all astronomical by which his theory must stand or fall.

Test No. 1: The theory of relativity, he said, must explain and remove the discrepancy between the predicted motion and the observed motion of the planet Mercury. This little brother of the earth, revolving around the sun at an average distance about one third as great as the earth's distance from the sun, refused to follow the path assigned to it by Sir Isaac Newton's law of gravitation. The discrepancy was very small, but nevertheless certain. For a half a century before Einstein, astronomers had sought diligently but in vain for the explanation. Promptly following the publication of Einstein's work, he himself as well as astronomer De Sitter of Holland applied the test to Mercury, and the theory of relativity accounted in full for the discrepancy referred to.

Test No. 2: The theory of relativity, he said, requires that a ray of light, say from a distant star, when passing close to the surface of our sun, should be bent slightly from its straight-line course by the gravitational pull of the sun upon the light ray and, in addition, as an effect of the curvature of the space in which the sun is immersed. That a ray of light should be subject to gravitational attraction and that space should be curved were results or hypotheses new to the world. Einstein urged that astronomers endeavor to observe the phenomenon at times of total solar eclipse, the only times when the test can be applied by photographing the eclipsed sun's surroundings in order to record on the photographic plates the images of the stars in the neighborhood of the sun—though of course these stars would be millions of times as far away from us as the sun is. The star images should be slightly displaced from their normal positions, he said, and those nearest the sun be displaced the most. In 1919 there occurred a total solar eclipse extremely favorable as to its astronomical elements, and the British Eclipse Committee, represented by astronomers Eddington and Davidson, sought to observe the Einstein phenomenon from Africa and Brazil. Unfortunately, both programs of observation were sorely afflicted by clouds and the images of only a few stars, none at all on some of the plates up to a maximum of seven stars on other plates, were recorded. Nevertheless, the measurements of the plates showed that the rays were bent from their straight-line courses in passing the sun, through angles approximately of the minute dimensions predicted by Einstein.

The William H. Crocker expedition from the Lick Observatory, University of California, represented by astronomers Campbell and Trumpler, observed the total solar eclipse of 1922 from the northwest coast of Australia, using four photographic telescopes specially designed and constructed to apply with great efficiency upon the Einstein test. The observing conditions were practically perfect. Hundreds of star images were recorded on the plates, all in excellent focus. The images of from 62 to 147 stars, on the ten plates, whose light had passed the sun at various distances were selected for measurement. The ten results from the ten plates were each in good and satisfactory accord with Einstein's prediction, and the combined results were essentially in precise accord with the predictions for the displace-

ments of the star images at their various distances, up to seven or eight degrees, from the sun.

Test No. 3: If the positions of the thousands of dark lines in the spectrum of the sun, representing the gases and vapors of the chemical elements composing the surface strata of the sun, be measured very accurately, it should be found, Einstein said, that the lines are displaced by an exceedingly small but definite amount toward the red end of the spectrum, because the strong gravitational pull of the sun upon the radiating materials at the sun's surface would affect the outgoing waves of light in such manner as to lengthen them slightly; and we know that a lengthening of the waves always shifts a spectrum toward the red end of it.

Several astronomers endeavored to observe this phenomenon, but by far the most comprehensive and successful test was that conducted by Dr. St. John, of the Mount Wilson Observatory, based upon photographs secured with the powerful tower telescopes on Mount Wilson. Although several influences in the sun are known to be capable of displacing the lines of its spectrum very slightly toward the red, yet St. John's results, after eliminating the other influences as well as possible, were in good agreement with the Einstein prediction.

A little later, through the work of Eddington and others, it became evident that the fainter component of the well-known double star Sirius, though known to be about as massive as our sun, is a surprisingly small but astonishingly dense body. A cubic inch of it, on the average, it is confidently believed, would weigh as much as 50,000 cubic inches of water. That is, a cubic inch of the star, if brought to us on the earth, would here weigh about 1,800 pounds. It was pointed out that the Einstein displacement of the lines in this star's spectrum should therefore be about twenty-seven times as great as for the lines in the sun's spectrum. Director Adams, of the Mount Wilson Observatory, using the 100-inch reflecting telescope, succeeded in the extremely difficult problem of observing this displacement, and he found it to be of the dimensions required by the Einstein theory. I may say, also, that Astronomer Moore, of the Lick Observatory, using the James Lick telescope, later succeeded in confirming Director Adams' results.

And thus did the theory of relativity meet and stand the three tests set for it by its distinguished author.

DR. MILLIKAN:

I now have the extraordinary pleasure of introducing Professor Einstein himself, but in doing so I wish to dispel a very common misconception, for the average man, who only knows science from afar, labors, I suspect, under the misunderstanding that we honor Einstein only because he was the author of the theory of relativity. Now, every physicist knows that the Nobel prize committee, which awarded him that honor in 1921, did not have to consider the theory of relativity at all in making that award. They might have given it on any one of at least four grounds, and the scientific world would have been unanimous in applauding the award on any one of them. I myself have the best of reasons for knowing which one of these four they actually chose, for the late Professor Gullstrand, the chairman of the Nobel committee, in making the 1923 award stated that it was the experimental verification of the Einstein photoelectric equation that removed all doubt as to its validity in the minds of the committee, so that they chose the first theoretical statement of that equation in 1905 by Professor Einstein as the basis of the award to him in 1921 and the experimental verification thereof as the half basis of the 1923 award. Now, this equation has nothing whatever to do with relativity, but I think that all students of modern physics will agree that it is of quite as far-reaching significance as is relativity, or, indeed, as is anything that has appeared in modern physics, for it necessitated, as soon as it was firmly established, our return to at least a semi-corpuscular theory of the nature of radiant energy. The extraordinary penetration and boldness which Einstein showed in 1905 in accepting a new group of experimental facts and following them to what seemed to him to be their inevitable consequences, whether they were reasonable or not as gauged by the conceptions prevalent at the time, has never been more strikingly demonstrated.

Any small contributions that I myself may have made to the progress of physics have been largely in the nature of experimental verification of predictions contained in three theoretical equations first set up by Einstein, and but one of these has had anything to do with relativity. The first of these was the Brownian movement equation (1905) whose verification by a number of observers removed the last doubts as to the atomic theory of matter; the second was the afore-mentioned photoelectric equation (also 1905), which changed radically our conception as to the nature of radiation; the third was the equation expressing the interconvertibility of mass and energy. This grew out of special relativity (also 1905) and it has recently predicted for me verifiable relations in the radio-active field, and it also constitutes the most important basis for the cosmic ray conclusions that I am now wishing to draw. All these three are of equal significance, I think, with the predictions from the general theory of relativity, the experimental verification of which Dr. Campbell has just described. You can throw general relativity into the waste basket, if

you will, and Professor Einstein's position as the leading mind in the development of our modern physics would still remain unchallenged. It is a very high honor to be able to introduce him to the associates to-night.

DR. EINSTEIN (*Translated by Professor William B. Munro*):

From far away I have come to you; but not to strangers. I have come among men who for many years have been true comrades with me in my labors. You, my honored Dr. Michelson, began with this work when I was only a little youngster, hardly three feet high. It was you who led the physicists into new paths, and through your marvelous experimental work paved the way for the development of the theory of relativity. You uncovered an insidious defect in the ether theory of light, as it then existed, and stimulated the ideas of H. A. Lorentz and Fitz Gerald, out of which the special theory of relativity developed. These in turn pointed the way to the general theory of relativity, and to the theory of gravitation. Without your work this theory would to-day be scarcely more than an interesting speculation; it was your verifications which first set the theory on a real basis.

Campbell's determination of the bending of rays of light coming past the sun; St. John's determination of the red shift of spectral lines due to the gravitational potential existing at the surface of the sun; Adams' determination of the red shift in the light which comes to us from the companion of Sirius—these provide the best support for the general theory of relativity.

Going beyond all this, the work of your wonderful observatory, through the recent discoveries of Hubble concerning the dependence of the red shift in the spectral lines of the spiral nebulae on their distance, has led to a dynamic conception of the spatial structure of the universe, to which Tolman's work has given an original and especially illuminating theoretical expression.

Likewise in the realm of the quantum theory I am grateful to you for important assistance because of your fundamental experimental investigations. Here I acknowledge gratefully Millikan's researches concerning the photo-electric effect, which first proved conclusively that the emission of electrons from solid bodies under the influence of light is associated with a definite period of vibration of the light itself, which result of the quantum theory is especially characteristic for the corpuscular structure of radiation.

While I let my spirit reflect upon all this, I account myself exceedingly fortunate to be able to break bread with you here in joyous mood, full of the happy conviction that your researches will continue through the future to broaden and deepen, without let or hindrance, our knowledge of nature's mysterious forces. From my heart I thank you all.

ADDRESS AT THE LUNCHEON[1]

THE presence here of hundreds of people to greet a distinguished man of science is a part of something without parallel in our American life. When newspapers everywhere continue, day after day, to give front page space to a man whose work does not directly touch the lives of the people, it signifies something unusual. The public itself would first catch the humor of a suggestion that it knows anything about relativity; and yet the warm interest in the man who has given us relativity continues.

Part of this interest is our spontaneous response to a gracious personality, full of modesty and kindness and humanity. For the rest, it means, I think, that our imagination has in some way been touched. We realize that Professor Einstein has done things on the remote frontiers of science where man seems to approach the mystery of his existence; we know that he has changed the space and time we thought a safe framework to which we might tie all our activities; that he has dared to think about the bounds of the universe itself. Those who have seen his work at first hand feel the beauty of its logical structure; others marvel that there could be any new way of thinking about stubborn old realities. And why shouldn't these things stir the imagination?

Nevertheless, Einstein himself would insist on the purely intellectual character of what he has done. He has remarked, "Relativity has nothing to do with the soul; it is a matter only for the head." But what intellectual achievement ever remained wholly detached from human feeling? The work of Copernicus was such an achievement. Yet it precipitated the bitterest of controversies because it tumbled man out from the place of honor in the center of the universe and suggested that he was of less importance than he thought. Again, the painstaking inductions of Darwin put life into the long-dormant doctrine of evolution; and you well know the emotional reactions to that intellectual effort. These are extreme instances; but even the work of Newton, which held no threat for man's cherished beliefs, profoundly influenced his outlook on life as well as his views of the physical world. And so, before such an achievement as relativity, we can not remain passive. Even though we know none of its details, we feel the freshening wind of new thought and find ourselves stirred; and we feel that it is good to be so stirred.

No one at this moment would dare predict how the

[1] Remarks on behalf of the Mount Wilson Observatory at a luncheon in honor of Professor Einstein, given by the Chamber of Commerce at Pasadena, California, February 24, 1931.

influences, direct and indirect, of Einstein's investigations are finally to be reckoned. Nevertheless, of their scientific aspect much may be said. We know that his contributions to physics in fields other than relativity would justify an award of the Nobel prize several times over, and we know the importance to both physics and astronomy of relativity itself. From these recognized accomplishments I turn to something that has received little comment.

In a sense scientific investigation is a game. The physicist must assemble his protons and electrons into a world—not any world, but one which has the properties of the physical world about us. As with all games, there are rules. Some of these are predetermined, for example, the fundamental rules of thinking. Others we choose for ourselves; and in this choice we have astonishing freedom. If I wish to arrange a shuffled pack of cards in sequences according to the four suits, you know a score of solitaire games, each with its own set of rules, by which this may be done. But it is not obvious that the game of world building may be played in more than one way. It remained for Einstein to show us that such is the case, and that if we judiciously change the rules we may still win fairly, with a greatly increased score. As a matter of fact, we have unconsciously been revising the rules of the game ever since men began to think in a scientific way; but we didn't realize it until Einstein drove it home in a way not to be ignored.

Thus with our notion of space. It may seem to you queer that space, which doubtless you think of as a great empty void, should have anything to do with rules. I don't know why it is that we so seldom point out to laymen that the space of physics and astronomy is not the void which separates objects from each other. The physicist never thinks of space apart from objects within it; in his mind is always the idea of distance—the distances of objects from each other. When he says that space has certain properties he is talking not about the empty void, but about how he makes measurements to find what these distances are. But you ask: Is he not obliged to measure distance in a definite way? The answer is, No. He may measure in any way he likes, along what we call a straight line for example; or, if he finds reason for so doing, he may measure along some curve connecting two objects and call that result the distance.

The physicist's space is therefore essentially a set of rules for measurement. Those used until Einstein suggested a change were unconsciously adopted by Euclid two thousand years ago. Until less than a century ago no one realized that by accepting one of Euclid's postulates we had committed ourselves to making measurements in a particular way, or that measurements could be made in any other way. Even then we looked upon the matter as a geometrical curiosity without practical significance; and by the time Einstein suggested the advantages of a change and we began to hear about curved space, our long-held ideas had become so fixed that readjustment was hard. For the layman it was even worse. He had in mind the empty void; and how could such a thing as a void be flat or curved? But if we say that curved space means only a new set of rules which require that measurements be made along curved lines, the idea at least makes sense, even though you may not be convinced that such a strange procedure is advantageous. But I assure you that it is, for it enables us to win the game with a score we could not otherwise attain. If that statement brings no illumination, let me ask you, What is the distance from here to New York? Your answer undoubtedly will be the miles measured over the curved surface of the earth, because that is the distance which every-day experience makes it useful to know.

As with our ideas of space, so with a dozen others. Each has been transformed and set before us in new light. Quite apart from the intrinsic importance of the results is the remarkable fact that such momentous changes of view-point could be made. By teaching us that, Einstein has put into our hands new power. The value of this service, it seems to me, can not be set too high.

And now, sir, that we must bid you farewell, let me thank you in the name of the Observatory for your friendly visit, for the companionship we have had with you, and for the inspiration your presence has brought us. We wish you Godspeed, and we hope that we may see you again soon.

FREDERICK H. SEARES
ASSISTANT DIRECTOR OF THE
MOUNT WILSON OBSERVATORY

THE REASON AND THE RESULTS OF DR. EINSTEIN'S VISIT TO THE CALIFORNIA INSTITUTE OF TECHNOLOGY

AT the time of the initiation of a strong department of physics at the California Institute in 1921 provision was made for bringing each year an outstanding European scientist to join the staff of the institute as foreign visiting professor on temporary appointment.

This professorship has been held twice by the late Dr. H. A. Lorentz, of Leiden, Holland, twice by Dr. Arnold Sommerfeld, of Munich, Germany, once by Dr. Bjerknes, of Oslo, Norway, once by Professor Raman, of India, twice by Professor Ehrenfest, of Holland; and as long as five years ago Professor Einstein, of Berlin, accepted appointment to come to Southern California to this same foreign professor-

ship but was prevented by a breakdown in his health from carrying out his plan at that time.

Three or four times since then, however, he has expressed a desire to come to the institute for purely scientific purposes, since the extensive experimental and theoretical researches being carried out both at the Norman Bridge Laboratory of Physics and the Mount Wilson Observatory were very intimately related to his own work, and a first-hand interchange of ideas was certain to be profitable to the men working in this center while an intimate view, especially of our experimental conditions and results, could scarcely fail to affect in some way Professor Einstein's own thinking.

After repeated interference, by untoward events, with the long-contemplated visit it has been made a reality this winter with results that are all that could be expected by the "Einstein collaborators" on the spot, namely, Eric T. Bell, Walter S. Adams, Richard C. Tolman, Charles E. St. John, Roy J. Kennedy, Paul S. Epstein, Harry Bateman, Edwin S. Hubble, Theodor von Karman, Albert A. Michelson, Fritz Zwicky, J. Robert Oppenheimer, Martin L. Humason, William V. Houston, Robert A. Millikan, Ira S. Bowen, Jesse W. DuMond, Linus C. Pauling, Francis G. Pease, Edward M. Thorndike, Ernest C. Watson, S. J. Barnett, Frederick H. Seares, Arthur S. King and Gustaf Stromberg. Every one of this considerable group of men who have made contributions either to some phases of the Einstein theories or to the experimental verification of these theories has been stimulated and inspired by Einstein's presence and the discussions with him that have been made possible by his stay here.

It is hoped, too, that Dr. Einstein himself has profited by the sight he has had of the extent and character of the new experimental results that have recently been brought to light by the aforementioned group of workers, and that he will feel the urge to repeat his visit, as Lorentz, Sommerfeld and Ehrenfest have done before him. His quite extraordinary human sympathy and insight, combined with his charming modesty, honesty, open-mindedness and objectivity, have made his visit an inspiration and a rich experience to all of us, whether we have been directly associated with Einstein's work or not.

Robert A. Millikan

It is quite impossible to estimate fully the influence of Professor Albert Einstein's visit to Pasadena and to the Mt. Wilson Observatory of the Carnegie Institution of Washington until many more years have passed.

The intangible results of the contact of this great master of science with the life and work of the observatory are likely to prove fully as important as will any of the notable lectures and discussions in which he has taken part so generously.

Among the specific problems of astronomy which Professor Einstein has considered during his visit there is none which makes so strong an appeal both to the mind and the imagination as that of the nature and structure of the universe.

In a clear and brilliant summary he has outlined the consequences of the different methods of treatment of the equations of generalized relativity and the aspects of cosmology to which they lead.

The recent discoveries of the large red-shifts in the spectra of the most distant nebulae and the enormous apparent velocities which they indicate, together with the direct relationship found to exist between distance and amount of red-shift, have modified greatly some of the earlier views.

Professor Einstein is now inclined to consider the most promising line of attack on this problem to be based on theories of a non-static universe, the general equations for which have been developed so ably by Dr. Richard Chace Tolman, of the California Institute of Technology. In the special solutions so far made involving an expanding universe the chief difficulty lies in the insufficiency of the time-scale which they require.

Of special interest to the members of the observatory staff have been Professor Einstein's outline of the method and development of the unified field theory; his suggestive discussion of the possible origin of circulatory movements in the solar atmosphere and their bearing on the rotation of the sun and the formation of sun-spots, and the valuable insight he has given us into his interpretation of some of the equations governing the probability of transitions within the atom, a field of vast importance in spectroscopy and one with which his name is associated most intimately.

His insistence upon the necessity and importance of the results of observation to control theoretical assumptions and developments has been a striking characteristic of his mode of thought.

Beyond any other consideration, however, has been the opportunity of observing his keen and brilliant mind at work, its instant grasp of the essentials of a problem and its extraordinary resourcefulness in its solution.

Finally, no one can meet Professor Einstein even for the first time without an immediate realization of extraordinary intellectual power combined with a natural simplicity and kindliness which so often characterize great genius.

Walter S. Adams

OBITUARY

JAMES PERRIN SMITH

Dr. James Perrin Smith, professor emeritus of paleontology at Stanford University, died suddenly at his home in Palo Alto, California, January 1, 1931.

Dr. Smith was born at the home place on Saluda River, near Cokesbury, Abbeyville County, South Carolina, November 27, 1864. He was the son of the Reverend James Francis and Julia (Forster) Smith. His parents were highly cultured, and realizing the value of an education they were anxious that their children should have every opportunity possible of securing a thorough one. The public schools in the vicinity of Cokesbury were very poor, and on account of this James Perrin was taught at home. His parents moved to Spartanburg, South Carolina, while he was still quite young, so that he might have the advantages of the schools there. He entered the preparatory school of Wofford College and from 1876 to 1879 was under the tutorship of Charles Forster Smith, an elder brother. In the fall of 1880 he entered Wofford College and in 1884 was graduated with the A.B. degree. He then entered Vanderbilt University, where he was a student from 1884 to 1887, receiving the M.A. degree in 1886.

Following his work at Vanderbilt he taught for two years in the Nashville, Tennessee, high school. In 1888 Smith was appointed assistant chemist and geologist for the Arkansas Geological Survey, which had been but recently organized.

At that time it was the custom to go to Germany for advanced scientific work, and so Smith entered the University of Göttingen to study paleontology under Professor von Koenen and mineralogy under Professor Liebisch. He received the degree of doctor of philosophy in paleontology in 1892. In the spring of 1892 he spent a short time in Munich under the instruction of Professor von Zittel. During his two years at Göttingen Dr. Smith was devoting all his spare time to the study of the ammonites, a group in which he had become very much interested. Having finished his work at Göttingen he returned to the United States.

Stanford University had opened in the fall of 1891, and Dr. John Casper Branner had been appointed head of the department of geology. In 1892 he selected Dr. Smith as his associate, with the title of professor of paleontology and mineralogy. For a number of years Dr. Smith gave courses in historical geology, paleontology, mineralogy, crystallography and petrography. In 1905, however, he was made professor of paleontology and was relieved of his work in mineralogy, crystallography and petrography. On taking up his work at Stanford Dr. Smith continued his study of the ammonites, making collecting trips and studying the stratigraphy of various parts of the western United States.

He also became interested in California geology and in time was regarded as an authority on the subject. In 1916 he supervised the compilation of a geological map of California and to accompany it prepared a report descriptive of the geologic formations of the state. These were published by the California State Mining Bureau.

The writer has known Dr. Smith for the past thirty-five years, first as a teacher in the classroom and in the field and later as a very personal friend and associate. As a teacher he was held in the very highest regard by all his students and associates. He had the faculty of getting from each one the very best results that were possible. He was first and always a teacher. Other monuments may be erected in his honor, but his chief monument will be the affectionate memory of the students who during his thirty-seven years of teaching profited by his instruction and association. The influence of Dr. Smith on his students was by no means confined to the class room. In fact, his habit of meeting students in groups in front of the Geology building and telling stories and discussing various problems with them has had a very marked influence on the lives of many persons. He was never too busy to listen to students when they had real problems to discuss with him and they were sure of a sympathetic audience and good sound advice.

The very deep regard in which Dr. Smith was held by his former students was shown when, on his retirement as executive head of the geology department at Stanford University in 1922, the graduates of the department presented him with ten thousand dollars. This was one of the most unusual tributes ever paid to any teacher.

Dr. Smith had a very high standing as a scientist and while his specialty was invertebrate paleontology, at the same time he had a thorough knowledge of the other phases of geology. He early became interested in the ammonites and devoted his whole life to a study of this group of fossils and was recognized internationally as an authority on it. He was especially interested in working out the evolutionary stages of the various forms and in studying them from a biological as well as geological standpoint.

From 1895 to 1906 Dr. Smith held the title of assistant geologist on the U. S. Geological Survey and from 1906 to 1924 the title of geologist. In this partial relation he devoted his spare time from university duties to the collecting and study of ammon-

ites. From this there resulted a notable series of publications. In 1902 his paper on the "Carboniferous Ammonoids of America," 205 pages and 29 plates, was published by the U. S. Geological Survey as Monograph 42. This was followed in 1905 by his paper, with Alpheus Hyatt, entitled "Triassic Cephalopod Genera of America," U. S. Geological Survey Professional Paper 40. It contained 394 pages and 85 plates. In 1914 his paper, "Middle Triassic Marine Invertebrate Faunas of North America," appeared as Professional Paper 83, U. S. Geological Survey, 254 pages and 99 plates, and in 1927 "The Upper Triassic Marine Invertebrate Faunas of North America" was published by the U. S. Geological Survey as Professional Paper 141, with 363 pages and 121 plates. Still another paper, "The Lower Triassic Ammonoids of North America," was completed at the time of his death and will be published by the U. S. Geological Survey.

While the above are Dr. Smith's largest papers and perhaps the most important ones, he published more than fifty others. The high character of his scientific work was recognized by the best scientists of the country when in 1925 he was elected to membership in the National Academy of Sciences and on April 24, 1928, was awarded the Mary Clark Thompson Gold Medal for his research in geology and paleontology.

Dr. Smith was married August 19, 1896, to Miss Frances Norris Rand, of Manitowoc, Wisconsin. They had four children, Mary, Forster, Howard and Charles. The daughter and two sons have graduated from Stanford, and the youngest is still in the university.

In addition to his other work Dr. Smith served on various university committees and in many ways was a very important influence not only in determining the policy of the geology department but of the university as a whole. He belonged to but few scientific societies. He was, however, a very loyal member of the Le Conte Club and attended practically all the meetings. He was much interested in sports of various kinds and as a college student was pitcher for his college baseball team. In later years he became very fond of fishing as a diversion in summer vacations.

Dr. Smith was one of the most kind and lovable men it has ever been my privilege to know. He was uniformly courteous, exceedingly modest and unassuming and possessed the very highest sense of honor. This last was well shown in his scientific work, where he insisted full credit should be given each one for any work done. He gave very freely, however, of his own material to his advanced students.

While we mourn deeply his loss we have the very great satisfaction of having had the privilege of knowing him and of being associated with him for so many years.

SOLON SHEDD

STANFORD UNIVERSITY

RECENT DEATHS

DR. ALBERT PAUL WEISS, professor of psychology at the Ohio State University, died on April 3, at the age of fifty-one years.

DR. OTTO WALLACH, emeritus professor of chemistry in the University of Bonn, died on March 1, at the age of eighty-four years. Dr. Wallach was awarded a Nobel prize in 1910 for his work on terpenes.

THE death is announced of Dr. Johannes Reinke, professor of botany at Kiel.

PROFESSOR D. HEPBURN, of the department of anatomy of the Cardiff Medical School, University of Wales, died on March 10, at the age of seventy-two years.

Nature reports the death of Henry Harries, long connected with the British Meteorological Office, on February 8, at the age of seventy-nine years, and of Professor Carl Emil Hansen Ostenfeld, professor of botany and director of the botanical garden in the University of Copenhagen, on January 16, aged fifty-eight years.

SCIENTIFIC EVENTS

GEOPHYSICAL SURVEYS

A SPECIAL exhibition of apparatus and equipment used in geophysical surveys has been opened in the Science Museum, South Kensington. The exhibits, as described in the London *Times*, have been specially selected to illustrate the development of all the important methods used to locate mineral deposits by the use of sensitive physical apparatus, and the display, though preceded by a smaller exhibition in Stockholm last year, is the first attempt to assemble on a large scale instruments up to the most modern examples. Details of field operations and the technique of the various methods are illustrated by photographs and diagrams, and examples are shown in maps and large scale plans of the results obtained by geophysical surveys in various parts of the world.

The exhibition begins by illustrating general magnetic principles, through specimens of William Gilbert's "terrella" or circular loadstone of date about 1600, specimens of which are lent by the Royal Society. The sixteenth-century sundial compass, and the wooden-bowled mariner's compass of the mid-sev-

enteenth century are shown for comparison with the Chinese geomancer's compass, and the various forms of dip circle which show the natural inclination of the compass needle. The magnetic compass was used in special forms of design for mining purposes from the middle of the seventeenth century, and it is fairly easy to understand the working of examples lent from Sweden, but the instruments become increasingly complicated as the visitor proceeds, though the "Watts Vertical Variometer," a new type of British instrument evolved in the present year, is neatly and comprehensibly made.

A second method relies upon the gravitational effect exercised by bodies proportionally to their mass, and its practical application to prospecting dates only from 1888, when the Eötvös torsion balance was invented. Progress with instruments involving this method has been particularly rapid in the past five years, and a novel form of apparatus designed by Captain H. Shaw and Mr. E. Lancaster-Jones, two members of the staff of the Science Museum, has recently come into use.

Another section of the exhibition shows the seismic method of investigation, which consists in testing the rate at which a small artificial earthquake (usually an explosion) is propagated over various points, the elasticity of the local crust of the earth being discovered by these means, while the fourth method, that of testing electrical interference by mineral bodies, is shown in a separate range of instruments.

CUSTOMS DUTIES ON SCIENTIFIC APPARATUS

THE imposition of the appropriate customs duties upon scientific apparatus imported into the United States by the University of Illinois, a state agency, through the port of Chicago, is reported by the *United States Daily* to have been upheld by Justice George M. Young, of the United States Customs Court.

Protest was lodged against this assessment of duty upon the following ground:

> That such merchandise should come in without duty, as being imported by an instrumentality of the Government of the State of Illinois, for use in the execution of a government function and purpose, under the well-established policy of the Federal Government not to tax the states or their agencies and subdivisions.

At the trial it was argued that the Federal Government has no authority to impose duty upon imports made by the State of Illinois.

The attorney for the University of Illinois, Mr. Sveinbjorn Johnson, contended that the exaction complained of is a tax; that the property upon which it is sought to be levied is property used necessarily and exclusively by the University of Illinois as an educational agency; that the university is a state agency, and that education is a governmental function, so that the agencies and properties, used in connection therewith, are exempt from federal taxation as instrumentalities of the state created and used to facilitate the exercise of a governmental as distinguished from a proprietary purpose.

In his opinion, upholding the imposition of the tariff assessment, Judge Young stated:

> If this and similar tariff taxes on goods imported by a state university were raised so high as to prohibit the articles from importation, would that destroy the institution, assuming that it is a governmental instrumentality of the state? If it would, then the tariff is invalid. If not, then it is constitutional.
>
> Counsel for the plaintiff contends that the power to levy such a tax is the power to prevent its use by the consumer. We admit that this is true, but if the University of Illinois were prevented entirely from making importations, would it be destroyed? We believe not.
>
> The existence of the states is in no way threatened by such duties. Even if the duties should be made so high as to preclude their importation, it would not result in destroying the university or seriously impairing its usefulness.
>
> The constitutional implication preventing the Federal Government and the state from taxing each other's agencies must receive a practical construction permitting each government to function with a minimum of interference with the other.
>
> We therefore hold that the plaintiff herein, the University of Illinois, has no constitutional exemption from the payment of duties collected in the case at bar.
>
> The defendant (the Federal Government) is entitled to judgment.

THE SINNOTT MEMORIAL IN THE CRATER LAKE NATIONAL PARK

VISITORS to Crater Lake National Park, Oregon, next summer will benefit from the recent action of the Carnegie Corporation in donating $5,000 for the furnishing and installation of equipment in the Sinnott Memorial located there.

This structure, authorized by Congress last year in connection with appropriations for the National Park Service, is a memorial to Representative Nicholas J. Sinnott, of Oregon, who took a keen interest in the park and did much to further its use by the public. In providing for the memorial Congress appropriated $10,000 for its construction, acting upon the suggestion of the Honorable Louis C. Cramton, then chairman of the subcommittee of the House Appropriations Committee handling Interior Department appropriations.

The Carnegie fund for the development of the memorial has been transmitted through the National

Academy of Sciences, which has appointed a committee to cooperate with the National Park Service in the installation of equipment. Dr. John C. Merriam, president of the Carnegie Institution, is chairman of this committee. The other members are Dr. Frederick Whiting, president of the Art Federation; Dr. David White, National Academy of Sciences; Dr. Fred Wright, of the Geophysical Laboratory; and Mr. Charles W. Eliot, 2nd, of the National Parks and Planning Commission. It is also hoped that Mr. Frederick Law Olmsted, nationally known landscape architect, may accept appointment to the committee. Development of the museum will proceed under the supervision of Ansel F. Hall, senior park naturalist of the National Park Service, who while in Washington recently conferred with this committee.

The memorial will be developed with a twofold purpose: To bring to the visitor to the park an adequate idea of the beauty of the picture presented, and to furnish interesting scientific data as to the formation of the crater in which the blue lake lies and its geologic history.

A DIVISION OF PLANT PATHOLOGY AT THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

Dr. Louis O. Kunkel, at present pathologist at the Boyce Thompson Institute for Plant Research at Yonkers, New York, has been appointed a member of the Rockefeller Institute for Medical Research in charge of a division of plant pathology, to be established in connection with its Department of Animal Pathology situated near Princeton, New Jersey. The combined laboratories will hereafter be known as the Department of Animal and Plant Pathology of the Rockefeller Institute. The department is located on a tract of approximately eight hundred acres of land at Plainsboro, New Jersey, three miles from Princeton University. With the addition of plant pathology to the subjects studied in its group of laboratories and hospital, the Rockefeller Institute will include in its scientific work all the main branches of the pathology of living matter. For the first time human pathology, the pathology of lower animals and that of plants will have been brought together into one closely knit investigative unit.

Dr. Kunkel was born in Audrain County, Missouri, on May 7, 1884, and studied and received degrees at the University of Missouri, Washington University, St. Louis, and Columbia University. He was Cutting Traveling Fellow of Columbia University during 1915–16, when he studied in Stockholm, Sweden, and in Freiburg, Germany. He taught at the University of Missouri and at Columbia University, and later became pathologist to the Bureau of Plant Industry in the U. S. Department of Agriculture, then associate pathologist with the Hawaiian Sugar Planters' Association, and in 1923 pathologist at the Boyce Thompson Institute for Plant Research.

Dr. Kunkel has been a contributor to the pathology of plant diseases, and his most recent investigations relate to the virus diseases of certain economic and ornamental plants. He has made contributions to the knowledge of the mosaic diseases of tobacco, sugar cane and corn, and of the virus disease of asters known as "yellows."

The constantly increasing number of diseases of man and lower animals discovered to be induced by filter-passing viruses brings the pathology of animal and plant diseases into intimate association. That both animal and plant pathology will profit materially by being investigated in close relationship may be taken as assured.

Dr. Kunkel will spend a period abroad, visiting institutions in which the study of plant pathology is pursued, before designing the new laboratories and establishing the new division of the Rockefeller Institute at Princeton.

CONFERENCE ON THE PROMOTION OF INTEREST IN PHYSICS

The Council of the American Physical Society is considering how best to promote interest in all branches of physics and realizes that already existing organizations of students, teachers and users of physics may, in many places, be the best agencies for this purpose. In order to cooperate properly with these organizations and in order to assist if called upon in the formation of new groups, the society invites all who are interested to attend a conference for the informal discussion of some of the questions that have already presented themselves. The most pressing of these are:

1. Should the American Physical Society, or any larger organization, publish a journal of general interest to physicists? If so, what should it contain and how frequently should it appear?

2. Should the American Physical Society assist local organizations in arranging for programs of special interest, as, for example, by supplying lecturers?

3. How should the cost of desirable additional activities be met?

Other questions appropriate to the general purpose of the conference will be discussed if time permits.

The conference will be held at 8:00 p. m. on Thursday, April 30, in the National Academy of Sciences Building, B and 21st Streets, Washington, D. C. Professor L. W. McKeehan, Yale University, chairman of the American Physical Society's committee on sections and local groups, will be glad to

receive, as soon as possible, information or suggestions for presentation by those unable to attend in person.

BIRTHDAYS AND RESEARCH CENTERS

UNDER this title *Nature* is publishing each week under the birthdays of scientific men occurring during the week autobiographical notes on the work that they are doing. The four statements in the issue of March 21 include the following:

March 22, 1868—PROFESSOR ROBERT A. MILLIKAN, chairman of the executive council of the California Institute of Technology and director of the Norman Bridge Laboratory.

I am still pursuing quite intensively my studies in the field of the cosmic radiations; for they have relations to meteorology not yet fully explored, and their values at very high altitudes still have something to teach us about the precise nature of the cosmic atom-building processes. Also, as an adjunct to these studies, I am interested in the problem of the origin of the very heavy elements and, as a possible clue to its solution, am collecting further data, by a new method, on the terrestrial distribution of the radioactive elements. Artificially stimulated radiations of high penetrating power are also a part of the program.

March 25, 1863—DR. SIMON FLEXNER, For. Mem. R.S., director of the Rockefeller Institute for Medical Research.

The constantly growing number of those diseases of man, the lower animals and plants shown to be brought about by filterable agents or viruses, emphasizes their known significance. Among human beings, a disease of this character is poliomyelitis or infantile paralysis. The modes of infection and of extension of the virus of this disease are questions of outstanding importance. Ever since 1909, when the first serial transmission of the disease to monkeys was accomplished (Flexner and Lewis), those questions have commanded attention. The indications, then secured and since confirmed, are to the effect that the virus is nerve conducted, as it enters and even as it leaves the body of infected human beings and animals *via* the respiratory mucous membranes.

Not only is this finding of importance in so serious a disease as poliomyelitis, but corresponding questions are of high interest in connection with virus diseases generally, as is also the question of the precise nature (chemical or otherwise) of the viruses themselves.

SCIENTIFIC NOTES AND NEWS

ACCORDING to press dispatches Professor Albert A. Michelson has improved after a somewhat critical nervous collapse. Dr. Michelson has been carrying on his experiments in the vicinity of Pasadena, measuring the velocity of light in a vacuum tube. It is said that he has been working until after midnight, returning from the Irvine Ranch, near Santa Ana, at three o'clock in the morning. The experiments are being continued during Dr. Michelson's illness by his assistants, Dr. Francis G. Pease, of the Mount Wilson Observatory, and Dr. Fred Pearson, of the University of Chicago.

PROFESSOR G. H. PARKER, director of the Harvard Zoological Laboratory, has been elected an honorary member of the Philosophical Society of Cambridge, England.

M. ELIE CARTAN, professor of mathematics at the University of Paris, has been elected a member of the Paris Academy of Sciences to succeed the late Paul Appell.

DR. PHILIP FURTWÄNGLER, professor of mathematics at the University of Vienna, has been elected a member of the Prussian Academy of Sciences.

THE University of Edinburgh will confer the honorary degree of doctor of laws at the graduation ceremonial on July 2 on: Dr. E. J. Allen, director of the Marine Biological Laboratory, Plymouth; on Sir George Berry, member of Parliament for the Scottish universities, formerly lecturer in ophthalmology in the University of Edinburgh, and on Sir Walter Morley Fletcher, secretary of the Medical Research Council.

AT a meeting of the senate of the University of London, Sir John Rose Bradford, president of the Royal College of Physicians, was nominated to receive the honorary degree of doctor of medicine, and Professor Kappers, of Amsterdam, the degree of doctor of science.

THE University of Darmstadt has conferred the honorary degree of doctor of engineering upon Bernard Arthur Behrend, of Wellesley Hills, Massachusetts, "for meritorious work in the construction of induction machines."

SIX chemists received the honorary doctorate of laws in connection with the dedication exercises of the building for chemistry, erected at a cost of $500,000, at Indiana University. These were: Dr. Fuanobu Isobe, chemical engineer of Tokio, Japan; Dr. O. C. Martin, chemical and metallurgical engineer, Antwerp; Dr. L. F. Rettger, chemist and bacteriologist, Yale University; Dr. O. B. Perry, consulting mining engineer, San Francisco; Dr. Earl Blough, chemical and metallurgical engineer, New York City; Dr. J. N. Currie, zymochemical engineer,

Brooklyn, New York. All are graduates of Indiana University.

In appreciation of the work accomplished in the Czechoslovakian Republic and of his contributions to agricultural science, Dean C. B. Hutchison, of the University of California College of Agriculture, has been decorated with the Order of the White Lion. The decoration was bestowed by Dr. K. Brejske, Czechoslovakian consul in San Francisco.

The American Geographical Society announces the award of the Charles P. Daly Medal for 1931 to Major Gunnar Isachsen, director of the Maritime Museum, Oslo, for his contributions to our knowledge of the Polar regions. Major Isachsen was topographer on the second Norwegian Arctic Expedition in the *Fram* under Otto Sverdrup (1898–1902) when important discoveries were made in the Canadian Arctic Archipelago. During 1906–1910 he spent four summers in Spitsbergen. Major Isachsen visited the Antarctic in 1926–1927 for study of the Norwegian whaling industry, an account of which he presented in the July, 1929, number of *The Geographical Review*. This last season, 1930–31, he commanded the *Norvegia* on her circumnavigation of the Antarctic, Consul Lars Christensen's project for study of the number and distribution of whales.

The Duddell Medal of the Physical Society of London, awarded for the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their construction, has been given to Sir Ambrose Fleming, and was presented to him by the president, Professor Sir Arthur Eddington, at the annual general meeting of the Physical Society, which was held on March 20. The connection of Sir Ambrose Fleming with the Physical Society of London dates back to its beginning, for he read the first paper at the inaugural meeting of the society in March, 1874.

The council of the Royal Society, as *Nature* records, has agreed to recommend for election as fellows of the society the following seventeen candidates: Percy George Hamnall Boswell, professor of geology in the Imperial College of Science and Technology; Alfred Joseph Clark, professor of pharmacology in the University of Edinburgh; Charles Davidson, assistant at the Royal Observatory, Greenwich; Reginald Ruggles Gates, professor of botany, King's College, London; Charles Stanley Gibson, professor of chemistry, Guy's Hospital Medical School; Hermann Glauert, principal scientific officer, Royal Aircraft Establishment, Farnborough; Charles Robert Harington, reader in pathological chemistry in the University of London; Isidor Morris Heilbron, professor of organic chemistry in the University of Liverpool; Sir Alexander Cruikshank Houston, director of water examinations to the Metropolitan Water Board; Lieutenant-Colonel Sydney Price James, adviser on tropical diseases to the British Ministry of Health; Charles Frewen Jenkin, lately professor of engineering science in the University of Oxford; Stanley Wells Kemp, director of research, *Discovery* Expedition; Thomas Howell Laby, professor of natural philosophy, University of Melbourne; William Kingdon Spencer, paleontologist; Edward Charles Titchmarsh, professor of pure mathematics, the University of Liverpool; Wilfred Trotter, surgeon to University College Hospital; Miles Walker, professor of electrical engineering, University of Manchester.

Professor E. J. Garwood has been elected president of the Geological Society of London. The vice-presidents are Mr. J. F. N. Green, Professor J. W. Gregory, Dr. H. H. Thomas and Professor W. W. Watts.

Dr. Charles L. Christensen, the newly elected dean of the College of Agriculture of the University of Wisconsin, has taken up his work at the university, after closing up his affairs as secretary of the Federal Farm Board.

Mr. H. J. Spelman, chief engineer of the West Virginia State Road Commission, has resigned to take a position with the U. S. Bureau of Roads in Washington.

Dr. Bradford Willard has been appointed a correspondent of the *Revue de Géologie* for the Pennsylvania Topographic and Geologic Survey.

Mr. A. L. Colton, for the last seven years on the editorial staff of the Bureau of Entomology, retired in February. Mr. Colton formerly served as assistant astronomer at the Lick Observatory and taught physics at the University of Wisconsin.

Mr. William R. Barbour, formerly in tropical forestry work in Haiti and other Caribbean countries, has been detailed by the Forest Service to organize a forestry program for the Virgin Islands. He has reported for work at St. Thomas and has begun a survey of forest conditions on the islands.

Dr. E. V. McCollum, professor of biochemistry at the Johns Hopkins University, has been appointed by the Secretary of Agriculture as delegate to the International Dairy Congress in Copenhagen.

Dr. Louis T. More, professor of physics and dean of the Graduate School of the University of Cincinnati, sailed on April 4 for Europe with his brother, Dr. Paul Elmer More, professor of philosophy at Princeton University.

PROFESSOR K. F. WENCKEBACH, of the University of Vienna, has been invited by the Queen Wilhelmina Jubilee Foundation to investigate the pathology of the heart in acute beri-beri at the recently established medical faculty at Batavia in Java.

DR. ARNO B. LUCKHARDT, of the University of Chicago, delivered a lecture at Ohio University on "Highlights and Shadows in the History of Anesthesia" on March 11. This lecture was the second of a series given under the auspices of the department of biology. The first lecture was given by Dr. Lawrence H. Snyder, of the Ohio State University, on "Clinical and Legal Aspects of Blood Groups."

SIR WILLIAM HARDY, of the Food Investigation Board of the Department of Scientific and Industrial Research and Low Temperature Research Station, Cambridge, England, will deliver the seventh Harvey Society Lecture at the New York Academy of Medicine, on Thursday, April 16. His subject will be "The Use of Cold in the Analysis of Physiological Function."

DR. B. M. DUGGAR, professor of plant physiology in the University of Wisconsin, will give the invitation address in connection with the annual initiation of the Iowa Chapter of Sigma Xi on April 29.

DR. MAURICE A. BIGELOW, professor of biology at Teachers College, Columbia University, and chairman of the executive committee of the American Social Hygiene Association, will deliver a lecture entitled "Social Hygiene and the Family" in London, on April 21, under the auspices of the British Social Hygiene Council. The Duchess of Atholl, M.P., will preside.

IN the issue of SCIENCE for March 27, the name of the president of the Columbia Chapter of Sigma Xi was incorrectly given. It should have been given as Professor Jerome J. Morgan.

THE first scientific meeting of the recently founded German Society for Internal Medicine and Neurology in the Czechoslovakian Republic was held at Prague on March 7 and 8, when the chief subject for discussion was the modern treatment of blood diseases.

THE Second International Congress of the History of Science and Technology will take place in London from Monday, June 29, to Friday, July 3, 1931. The headquarters will be the Science Museum, South Kensington. The congress, which originated with the Comité International d'Histoire des Sciences, founded at Oslo on August 17, 1928, meets annually in Paris and organizes every three years a congress in which those interested in the history of science and technology are invited to take part. For the coming congress the Comité has been fortunate in enlisting the cooperation of its parent body, the Comité International des Sciences Historiques, together with that of two other international societies—the History of Science Society and the Newcomen Society for the Study of the History of Engineering and Technology. The aim of the congress is to provide opportunity for intercourse and exchange of thought between all those who are interested in the various departments of the History of Science and Technology. The program is being arranged to cover the period indicated. Besides scientific communications, there will be social gatherings, visits to institutions and excursions to places of historic interest. Further particulars can be obtained on application to The Hon. Sec. International Congress of the History of Science, The Science Museum, South Kensington, London S. W. 7, England.

THE fifty-ninth convention of the Electrochemical Society will be held at Birmingham, Alabama, on April 23, 24 and 25. The three main sessions will be devoted to "Ceramics," "Electronics" and "The Electrodeposition of the Noble Metals," respectively. Birmingham is rapidly developing into one of the most important industrial centers of the United States, and members and guests of the society will have ample opportunity to visit a number of the leading industrial plants of the South.

THE eighth annual meeting of the West Virginia Academy of Science will be held at the West Virginia Wesleyan College, Buckhannon, West Virginia, on April 24 and 25. Sectional meetings will be held on Friday afternoon following the address of President A. B. Brooks, of Oglebay Park, Wheeling. A banquet will be held on Friday evening, after which Professor Roy Dorcus, of the Johns Hopkins University, will deliver the principal address. Saturday morning will be devoted to excursions to near-by points of interest.

THE Alabama Academy of Science held its eighth annual meeting on the campus of the University of Alabama on March 13 and 14. More than fifty papers were read and discussed. At a banquet attended by more than a hundred, President Emmett B. Carmichael read a paper on "The South's Contribution to Science." The visiting speaker was Dr. E. E. Reinke, head of the department of biology of Vanderbilt University, who discussed "The Highlands (North Carolina) Museum and Biological Laboratory Plans for a Mountain Research Station in the South." Officers elected for the year 1931–32 are: *President*, George Fertig, director of the Pittsburgh Testing Laboratories, Birmingham; *First Vice-president*, Herbert Martin, professor of chemistry, Auburn; *Second Vice-president*, H. C. Heath, professor of biology,

Woman's College, Montgomery; *Treasurer,* E. A. Hawk, fuel engineer, T. C. I., Ensley; *Editor of the Journal,* E. V. Jones, professor of chemistry, Birmingham-Southern College; *Councillor to the American Association for the Advancement of Science,* Emmett B. Carmichael, professor of biochemistry, University of Alabama; *Permanent Secretary,* J. L. Brakefield, professor of biology, Howard College, Birmingham. The academy will hold its ninth annual meeting in March 1932 at Howard College, Birmingham.

THE College of Medicine of the University of Illinois Chapter of Sigma Xi has announced the elections to the chapter for the year. There are three promotions from associate to active membership, eighteen elections to active, and twenty-two to associate membership. Of the forty elections to membership, twenty-one are faculty members, including two from the College of Dentistry and one from the College of Pharmacy. The balance of the elections are from the student body of the Graduate School, which numbers one hundred and twenty-one in graduate work in medicine and dentistry. The chapter has recently established an annual cash prize for the best original investigation by a student of the College of Medicine, Dentistry or the Graduate School. The chapter is unique in that it is the only one that has been granted so far to a college of medicine and is the second chapter granted to the University of Illinois. The only other chapter of the society in somewhat similar position is the chapter at the Mayo Foundation, which is the second chapter in the University of Minnesota. The officers of the chapter are: Dr. William F. Petersen, *President;* Dr. W. J. R. Camp, *Vice-president;* Dr. William H. Welker, *Secretary;* Dr. I. Pilot, *Treasurer; Executive Committee,* Dr. D. J. Davis, Dr. O. F. Kampmeier and Dr. H. A. McGuigan.

THE Louisiana Academy of Sciences, presided over by Professor F. G. Fournet, vice-chairman; the Louisiana-Mississippi Section of the Mathematical Association of America, presided over by Professor Irby C. Nichols, of Louisiana State University, chairman, and the Louisiana-Mississippi branch of the National Council of Teachers of Mathematics, under the presidency of Professor B. A. Tucker, held a joint meeting at the Louisiana State Normal College at Natchitoches on March 13. In addition to the technical papers presented at the scientific sessions an illustrated lecture on "The Great Cities of Ancient America" was given by Dr. Frans Blom, of the department of Middle American Research, Tulane University. The local branch of the American Association of University Women served tea to members of the societies and their guests, and the meeting closed with a banquet in the college dining hall.

THE *Journal* of the New York Botanical Garden reports that Dr. E. D. Merrill has recently presented to the library of the garden two Wedgewood medallions, one of Sir William Jackson Hooker, director of the Royal Botanic Garden at Kew from 1841 to 1865, and the other of his son, Sir Joseph Dalton Hooker, who was director from 1865 to 1885. These medallions were prepared from the original dies of earlier date in connection with the Fifth International Botanical Congress held at Cambridge, England, last August, at which Dr. Merrill was one of the five delegates representing the New York Botanical Garden. The various excursions arranged for visiting delegates before, during and after the congress included a pilgrimage to Halesworth Church, in Suffolk, for the dedication of a memorial tablet to Sir Joseph Hooker, born at Halesworth, and Sir William, who lived there for a number of years.

THE University of Wisconsin was recently made the beneficiary of $20,000 in the will of the late Mrs. Janet Van Hise, widow of Professor Charles R. Van Hise, formerly president of the university. The money will provide a research fellowship in the field of geology.

SIR WILLIAM BRAGG, director of the Royal Institution and of the Davy-Faraday Research Laboratory, spoke at a luncheon of the British Electrical Development Association at the Savoy Hotel on March 20, on the celebration of the Faraday Centenary in September. According to the report in the London *Times,* the guests numbered over five hundred and included visitors from France, Germany, Holland, Belgium and Austria. The president, Alderman E. Huntsman, presided. The chief feature of the Faraday celebrations, Sir W. Bragg said, "would be an exhibition in the Albert Hall illustrating the nature of Faraday's discoveries and the lessons to be derived from them. A statue of Faraday would be the center of the exhibition. At his feet one of his first experiments would be shown and the actual things be used—a piece of wire, a magnet and a drop of mercury. From this would spread, like the spokes of a wheel from its center, numerous exhibits showing the marvelous development of the uses of electricity in varied forms from that simple experiment. As Faraday by the charm and skill of his lectures had inspired his listeners with the beauty and uses of his discoveries, so the association must be at pains to cultivate the art of exposition. The British electrical industry ought to afford the greatest encouragement to the country. What our men had done in the past our men could do in the future."

DISCUSSION

A UNIFORM SCHEME FOR CITATIONS[1]

THE desirability of a standard scheme for footnote and other references to literature has been frequently set forth and is obvious to any one who has much contact with the 57 varieties now to be found. One of the government bibliographers writes:

> Bibliographical material at best is hard to read, and we believe that in order to fulfill its purpose it should be printed with the comfort and convenience of the reader in mind.

The difficulty would of course be lessened by a uniform scheme. Such a scheme, based on experience with thousands of citations, has been in use for many years in the publications of the U. S. Geological Survey and has proved entirely satisfactory. It can be exhibited best by sample citations of the two major classes:

> 1 (for an article or paper contained in a serial publication): Brewer, W. H., On the age of the gold-bearing rocks of the Pacific coast: Am. Jour. Sci., 2d ser., vol. 42, pp. 114–118, 1866.
>
> 2 (for an independent paper or book—that is, one not contained in a serial publication): Wright, W. B., The Quaternary ice age, 2d ed., p. 374, 1916.

If the place of publication and publisher's name seem necessary or desirable for more certain identification they are inserted just before the date.

The outstanding features of this scheme are the punctuation, the use (not omission) of the forms "ser.," "vol.," "pp.," etc., and the use of ordinary roman type throughout.

The punctuation keeps each citation together as a unit, the items being separated only by commas except that a colon is used to separate the title of an article in a serial publication from the title of the publication. If more than one paper by the same author is cited in a single reference a semicolon is used to separate the citations:

> Bouyoucos, G. J., Estimation of the colloidal material in soils: Science, new ser., vol. 64, p. 362, 1926; A rapid method for mechanical analysis of soils: Idem, vol. 65, pp. 549–551, 1927.

Some styles use a period after the author's name, after the title of the article, and before the date, each period followed by the same amount of space that is used between sentences in text. This breaks up the citation unnecessarily and is especially undesirable where more than one work is cited in a single reference. For example, one footnote in a recent Geological Survey publication contained references to four papers by three sets of joint authors—one paper each by two sets and two papers by the third set. In this footnote periods and sentence spaces were used only in two places—to separate the references to the different sets of authors. In the style just indicated it would have been broken up by thirteen periods and sentence spaces. Other styles use a colon after the author's name. This seems unnecessary, as a comma is adequate punctuation; moreover, the colon is needed in the place indicated above—between the title and the serial designation.

The scheme of omitting the forms "ser.," "vol.," "pp.," etc., and using parentheses for series number, black face for volume number, and colon preceding page numbers effects a small saving in space but is objectionable in every other respect. Its meaning is not clearly evident without an explanation, and it falls down in a citation that must include reference to a number (or part, Heft, Teil, etc.), as well as a series and a volume. With the abbreviated forms for these designations any one of average intelligence can understand a citation at a glance; without them even a reader familiar with the scheme is likely to be halted a few seconds in taking in the meaning. The government bibliographer already quoted says: "Too great emphasis on space saving may defeat the purpose of such compilations." Even the slight saving in space may not mean a saving in cost of printing, as some printers make an extra charge for composition in which black face type is used in combination with roman. Professor W. M. Davis, in a recent contribution to SCIENCE, states that it seems unnecessary to give the series number, as the date is sufficient to identify the series cited. If this is a valid argument the volume number might also be omitted in most citations. Certainly a publication issued in series, each series starting with volume 1, is not adequately cited if the series number is omitted. For example, the *American Journal of Science* is now in its fifth series and has had five volumes numbered 12. To compel the reader to identify the particular volume 12 by means of the date is shifting to him part of the author's burden. The need of omitting the series number disappears if the forms "ser.," etc. are used. In German citations in Geological Survey style the forms "Band," "Heft," "Hälfte," "Teil," "Abt." (for Abteilung), and "Lief." (for Lieferung) are retained for the sake of certain identification, but "p." or "pp." is used instead of "S." (Seite). In citations from other languages the English forms "vol." and "pt." (for part) are generally clear enough.

[1] Published by permission of the acting director, U. S. Geological Survey.

If a volume of a serial is paged continuously it is not necessary to cite the particular number. In "vol. 8, No. 3, p. 267," the "No. 3" is superfluous if page 267 is nowhere else in volume 8 than in No. 3. If the pagination starts afresh with each number that item must be included.

Of course under some conditions the need of saving space may be so urgent as to overbalance the disadvantage of omitting these terms. For example, in the list of geologic literature on North America from 1785 to 1918 (U. S. Geological Survey Bulletin 746) it was necessary, in order to keep the volume within reasonable dimensions, to cut the citations to the bone, and even the periods after abbreviations were omitted. In this book, which with all the condensation still contains 1,167 pages, the Brewer citation given above appears as "Am J Sc (2) 42: 114–118 (1866)" The plan was clearly explained in the introduction, however. Such exceptional conditions should not furnish a guide for ordinary practice.

In some styles the title of the paper or book cited is set in small capitals or inclosed in quotations; in others italic is used for the title of the journal cited. There is no need for such typographic distinctions. Plain roman "lower case" is easier to read than any other style. A title set in all small capitals is especially hard to read and is also typographically ugly.

In order of items the U. S. Geological Survey style corresponds to practically all other styles in most respects. The author's name is inverted, as it appears on library cards and in catalogs. If it seems necessary to identify the author by telling who he is, the designation is given in parentheses after his name: "McDonough, D. C. (American consul, La Paz)," etc. The position of the date of publication is sometimes questioned. It is placed last for several reasons:

(*a*) It appears last on the title-page of a book.

(*b*) In most references to serial publications the volume number is the principal distinctive item of identification and the date is simply additional information, more or less incidental, though important where questions of priority are involved. The distinctive item should be given first.

(*c*) A volume may run over more than one year, and the date used in the citation should of course be that of the particular pages cited. To write, for example, "vol. 43, 1893, pp. 6–20," and "vol. 43, 1894, pp. 296–371," is obviously less desirable than to put the date after the pages to which it belongs.

(*d*) The annual report of an organization covering the operations of one calendar year is of course not published until the following year. To put the date of publication directly after the title, as in "Arkansas Geol. Survey Ann. Rept. for 1928, 1929, pp. 24–36," is confusing, to say the least. These dates might be taken to mean a fiscal year covering parts of both 1928 and 1929, though the proper form for that would be "1928–29." Placing the date of publication at the end, however, removes the confusion. (To make such references to annual reports clear, the "for" should always be used, whether it appears on the title-page or not. If, however, the reports are numbered, as in "Fiftieth Annual Report," that is sufficient identification, and it is unnecessary to give the period covered.)

(*e*) An illustration of the difficulty arising when the date is put anywhere except at the end is afforded by the following citation: "Soc. géol. France Mém., sér. 2, vol. 8, No. 3, p. 404, 1868." Série 2 of the Mémoires comprises ten volumes, published at intervals from 1844 to 1877; volume 8 contains three papers, published in 1865, 1866, and 1868; the date 1868 applies to No. 3 and page 404 in this citation and to nothing else.

(*f*) Some journals are published in two volumes a year, and the date is thus not an exact indication of the particular volume cited. Here again the distinctive item should be given first.

It is occasionally desirable to arrange a list of citations chronologically. To emphasize this arrangement the date may be transposed from the end to the beginning of the citation, but no other change is required. When that is done a period is used after the date.

The one apparent exception in Geological Survey style to the rule of placing the date last is not a real exception. Some journals have no distinctive numeral designation other than the year of publication. For example, the Neues Jahrbuch für Mineralogie, Geologie und Palaeontologie has no distinctive volume number but is issued as Band 1 and Band 2 in each year. In citing this journal the year must be given as a substitute for the volume number—"Neues Jahrb., 1929, Band 2, pp. 67–104"—and is not repeated at the end. In such a citation the date is not really shifted from its normal position: it is used for another purpose, and then, repetition being unnecessary, it is omitted as the date of publication.

The standard abbreviations used by the Geological Survey for titles of serial publications are based in general on the principle of giving enough to indicate the words clearly. For example, "Jour." is used for Journal, not "J.," which might mean Jahrbuch or Jahresbericht.

The capitalization follows the usual library style. In English titles of books or papers only the first word, proper nouns, and proper adjectives are capitalized; in English titles of serial publications (usually abbreviated) principal words are capital-

ized. In foreign titles national practice is followed throughout.

The use of Latin terms in footnotes to avoid repetition of titles is confined to "op. cit." and "idem." "Op. cit." may be used if the previous reference is not far away, provided there can be no doubt as to what work is cited. If two works by the same author have been cited previously it is necessary to repeat the reference. "Idem" is used only for a second citation of the same work, immediately following the first, on the same page. "Idem" may represent all of the preceding citation except the page numbers, or it may be used to represent simply the journal just cited, the author and title being different. The forms "id.," "ibid.," "ibidem," and "loc. cit." are not used—not because they are not good Latin but for the sake of simplicity. Even "op. cit." should be used sparingly.

Most features of the Geological Survey scheme are regarded as having obvious advantages; a few represent simply a choice among different styles to insure uniformity. Owing to the vagaries of publishing organizations no scheme can provide for every difficulty that may arise. For troublesome citations that are not covered by the general rules common sense and analogy must serve as guides.

Bernard H. Lane,
Editor

U. S. Geological Survey

REGARDING TWIST IN CONIFERS

I was much interested in Mr. Chester K. Wentworth's article in the February 13 issue of Science concerning the twist in trees, especially at timberline in the Rocky Mountains. It has been my privilege to spend five years in the Colorado Rockies. During the summers of 1927 and 1928 I was stationed at the summer camp of the University of Colorado, which is located near timberline on the eastern slope of the Continental Divide. While here I spent much time studying the flora of the region and noticed particularly the twisted structure of most of the trees at timberline.

The same question asked by Mr. Wentworth was asked by members of different parties we were escorting, so two of the students and myself studied the question in an effort to find out what might be the cause of the twisting. We studied the living trees and those with one side alive, together with the dead ones in the vicinity. Knowing how hard it would be to prove an hereditary tendency toward twisting, we looked for an environmental explanation. From this angle three factors entered into our study, namely: (1) Direction of winter storms; (2) direction of prevailing winds during growing season; (3) natural protection, especially during the younger stages of growth.

It was obvious to the observer that the trees most strongly twisted were entirely devoid of branches on the upper or northwestern side. Upon studying the weather maps of the region we learned that the prevailing heavy storms of winter came from that quarter. These storms, laden with ice and sleet, cut off the small, tender twigs and consequently no branches were formed on the windward side. This left the tree much like a flag with the surviving branches pointing to the south and east. Further study of the weather maps together with our own knowledge of the summer winds told us that the prevailing winds of summer came from the south and west. We could now see that this lopsided tree with its branches on the east would be strongly whipped to the right during the time when its trunk cells would be most active and pliable. It is highly possible that this constant pressure to the right would strain the old fibers and also cause the new tissues to form in a slightly twisted condition. When the storms of winter came from the north and west the tree would tend to become untwisted but being dormant it would yield less in winter than in summer, consequently it would remain twisted. The only effect of the winter winds would be to destroy the tender twigs on the exposed portion of the "flag." The tendency would be to remove any twigs that may have been pushed farther to the right by the twisting during the summer. Thus the twigs would be built up on the left or south side of the "flag" in summer and be beaten off the right or north side in winter. During the lifetime of the tree it might mean the complete rotation of the upper part of the trunk. It is not uncommon to see branches twisted back over the top of the tree like huge arms pointing away from the wind. These may have been forced into this position by the process described above.

Twisting is not common in trees standing in thick timber, but occasional twisted trees are found at the edge of such stands. These trees may have been subjected to tornado twisting when young or may have been subjected to unequal strain when covered with drifted snow. This latter theory may account for left-handed twisting which is so infrequently observed. A few left-twisted trees were observed at timberline and with one exception these were protected in such a way by rocks as to receive the strong winds of summer at an angle which would cause the tree to be twisted to the left. This one exception stood out alone, but there were stumps of other trees near by which must have influenced its early growth. Both this tree and the dead stumps were protected from the northwest storms.

Twisting was not observed on the western slopes mainly because we were not stationed near these regions. It is likely that the same conditions would prevail there since the storms retained their same relative positions as on the eastern slopes.

Twisting of trees other than those at timberline has been observed and noted but not studied to any great extent. Apple trees are usually twisted in the prairie regions, but no definite set to the twist was noticed. It often occurred that both left and right twisting could be found in the same tree. In cutting up an old orchard that had died we found many trees of this type.

W. C. YEAGER

HOBSON SCHOOL,
SIOUX CITY, IOWA

THE GROWTH OF STALACTITES

AN occurrence, similar to that discussed by Professor Ellis in SCIENCE for January 16, 1931, "Concerning the Rate of Formation of Stalactites," came to my notice during an inspection of Fort Delaware in the summer of 1929.

Fort Delaware is situated on Pea Patch Island, in the middle of the Delaware River, 12 miles below Wilmington and is of the pre-Civil War type with walls of gray granite and interior finish of high grade brickwork. Though started in 1848, it was not completed until after the Civil War.[1] Thus the setting is similar to that at Fort Pickens.

Abundant growths of stalactites were found in process of development from the brick arches on many of the lower casements, the material for their growth being supplied mainly from the lime-natural cement-sand mortar but perhaps to a slight extent from the bricks, which showed some spalling due to water action. These stalactites varied as to type, many being of the slender, fragile variety described by Professor Ellis, with the larger ones reaching over a foot in length, while others were much stouter, with a length of four to five inches and a diameter of over one half inch, and were therefore strong enough to be readily collected. They consisted of a pure white carbonate of lime. Lime deposits also covered the floors of these casements to a considerable extent and in a few cases the development of stalagmites was beginning to be noticeable. Deposition was still in active progress.

As Fort Delaware had already become practically obsolete by the time it was completed, deposition may have been going on undisturbed for as long a period as 60 years. On the other hand, as there was some activity at the fort during the Spanish-American War, 30 years may be set as the lower limit available for the growth of the longer stalactites.

GRAGG RICHARDS,
Captain, 363rd Engineers, U. S. R.
DETROIT, MICHIGAN

[1] Charles H. Roe, "The Building of Fort Delaware," *The Military Engineer*, Vol. 21, pp. 350–354, July–August, 1929.

A CASE OF A BOY POSSESSING AN AUTOMATIC DIRECTIONAL ORIENTATION

IN a note in the *Psychological Bulletin*[1] twenty-two years ago H. C. Warren described the case of a boy who had an extraordinarily good sense of direction. A few months ago I wrote to this individual and asked him several questions about his sense of orientation. The answers received were all in the negative—that is, the individual disclaimed that he possessed any different sense of orientation than the ordinary person has who uses familiar objects or the sun as a guide. Whatever ability at orientation this individual had as a boy he has obviously lost as a man.

Recently a married couple who attended one of my classes reported that their son possessed an unusual sense of orientation to the points of the compass. He never seemed to get lost, they said, and when in a strange city could be relied upon to tell them in which direction they were going. While driving in an automobile through unfamiliar country he was able to tell the direction at any time.

With the cooperation of the parents I tested the boy in our psychological laboratory. I took him into a dark room, blindfolded him and confused him by revolving him (without, however, making him dizzy) in a noiseless rotating chair. After a few correct judgments he began to make large errors, and soon lost all absolute orientation. He oriented himself immediately as soon as he was permitted to see.

I convinced myself that he possessed no genuine "magnetic" sense of direction. This finding was corroborated by a story of his parents to the effect that if he went to sleep while riding in an automobile at night he was temporarily lost as to directions when he awoke. Regardless, however, of his lack of a sense of absolute orientation, it is exceedingly interesting that once he gains a true orientation during his waking hours he seems to remain oriented at all times. I might add that he is twelve years of age, above the average in intelligence and curious about everything that goes on around him.

His mother furnished an interesting bit of information on the origin of the development of this sense of orientation. As she is left-handed and frequently confuses "to the right" with "to the left," she used to give orders of the following sort to the youngster:

[1] H. C. Warren, "Magnetic Sense of Direction," *Psychol. Bull.*, 5: 376–377, 1908.

"Get me the brush on the north side of the dresser," "Go and sit in the chair on the east side of the porch." She did not do this to train his sense of direction but merely because it was more convenient and less confusing for her. Out of this training the boy has apparently developed the unusual ability to move about a complicated path for relatively long periods of time and retain his orientation without paying attention to the process.

From a theoretical angle the fact that this boy has learned to orient himself for long periods of time over a devious path while occupying his mind with many other things furnishes a clue to help us to understand how certain birds and animals can wander for long distances and find their way home over unfamiliar territory. If this boy can orient himself to the compass directions without voluntary attention to the task for long periods of time, then it is not difficult to conceive why certain animals, to whom such an ability would have an important survival value in hunting or being hunted, can likewise maintain this sense of continuous automatic orientation, if not to points of the compass, at least to their homes.

It is obvious that other factors need to be discovered to explain the case of an animal being blindfolded, confused and carried for a considerable distance and then finding his way home, but then many animals can not carry out this stunt. Perhaps in the few cases reported where animals have been successful in this performance, certain cues that might have enabled them to retain this continuous automatic orientation were not eliminated.

HARRY R. DESILVA
PSYCHOLOGICAL LABORATORY,
UNIVERSITY OF KANSAS

MENDELIAN DIFFERENCES

MAY I be permitted to correct an error of attribution before it becomes more widely spread in the biological literature. Dr. E. S. Russell, in his recent very interesting book, "The Interpretation of Development and Heredity" (p. 64), quotes Johannsen[1] as responsible for the conception that Mendelian inheritance deals with *differences* rather than similarities. It is necessary to point out that this conception originated in a paper of mine[2] in 1915, where the matter is fully developed. It was also referred to again in my book "The Mutation Factor in Evolution" (1915, p. 313).

It is worth pointing out that in the same paper (p. 141) Johannsen uses the conception of a particular constitution as characteristic of every cell in each genotype. This conception is clearly stated in "The Mutation Factor" (p. 297) and, as is well known, was based originally upon the Oenothera mutations which have an extra chromosome in every nucleus. It was further considered in various aspects in "Mutations and Evolution."[3]

R. RUGGLES GATES
UNIVERSITY OF LONDON,
KING'S COLLEGE, STRAND

[1] "Some Remarks about Units in Heredity," *Hereditas*, 4: 133–141, 1923.

[2] "Heredity and Mutation as Cell Phenomena," *Amer. J. Bot.*, 2: 519–528.

[3] New Phytologist Reprint No. 12, pp. 118, 1921, now published by the Cambridge Press.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE REMOVAL OF TRACES OF OXYGEN FROM NITROGEN

THREE general methods have been used to remove traces of oxygen from nitrogen: (1) To pass nitrogen through a solution which will remove the oxygen; some of the solutions used have been alkaline pyrogallol, ammonium cuprous chloride and alkaline hydrosulfite, with or without a catalyst as anthraquinone sulfonate suggested by Fieser.[1] (2) To remove oxygen with a solution such as ammonium cuprous chloride, which was placed in a large cylinder containing the gas under pressure; nitrogen, free from oxygen, but containing traces of ammonia, is delivered from the cylinder.[2] (3) To pass the nitrogen over a hot metal which will remove the oxygen and form the oxide of the metal; for this, copper has been shown to be much the most efficient, and has been used by the majority of investigators.

Variations in the potentials of solutions of cysteine which were observed in my laboratory when this type of purification was used indicated that under some conditions all traces of oxygen were not removed by the copper and suggested a reinvestigation of the problem concerned with the removal of oxygen from nitrogen.

Previous work had shown that a flow of between 200 and 500 cc of nitrogen a minute was desirable. For the removal of the traces of oxygen from this volume of nitrogen many different forms of tubes and furnaces were prepared and investigated. These need not be described in detail; the results eventually have led to a tube which has been thoroughly tested and has been proved to be satisfactory. It possesses several advantages when compared with the old type of copper furnace.

[1] L. F. Fieser, *J. Am. Chem. Soc.*, 46, 2638 (1924).

[2] H. Wartenberg, *Zeitschr. f. Elektrochemie*, p. 295 (1930).

Popoff[8] has suggested the use of the heated filament of a tungsten incandescent light for the purification of hydrogen. It was hoped that copper wire could be substituted for the tungsten and that it could be electrically heated to such a temperature that the traces of oxygen in nitrogen would combine with the copper oxide thus formed and would not be decomposed. With a 110 volt heating current, either an extremely long wire of large cross-section may be used or a shorter wire of small cross-section. No. 28 copper wire was chosen. A sufficient length to give 10 ohms resistance was wound on a triangular glass frame of pyrex rod. The frame was placed inside of a pyrex tube and suitable arrangements were made for the passage of the electric current and for the flow of nitrogen. It was then found that the wire expanded, short circuited and soon burned out.

This suggested a separation of the furnace into two parts, an inside heating element, and copper in the form of gauze to take up the oxygen. A cylinder of 40 mesh copper wire gauze 60 cm in length was wrapped around the outside of a 26 mm pyrex glass tube. Between the 26 mm glass tube and the copper gauze was placed a strip of mica which covered about a fourth of the surface of the inside of the copper gauze. Two thicknesses of copper gauze were wound around the tube and the strip of mica. The copper gauze was securely fastened with copper wire. The glass tube was then withdrawn, leaving a tube of copper gauze. This was placed inside of a pyrex glass tube 34 mm outside diameter and a coil of nichrome wire 0.5 cm in diameter, which contained 7.5 meters of No. 18 nichrome wire, was placed inside of the tube of copper gauze. A rod of silica 6.5 mm in diameter was placed inside the coil of nichrome wire to prevent distortion of the coil. The nichrome heating element rested on the mica. Copper wire for the connections to the heating element was sealed through the glass tube (Fig. 1).

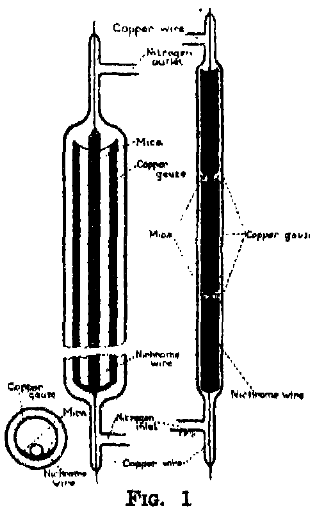


FIG. 1

[8] S. Popoff and A. H. Kunz, *J. Am. Chem. Soc.*, 51, 382 (1929).

Such a furnace has the following six advantages: (1) It is open for the free passage of the gas, the heating element and the copper occupy only a small part of the cross-section of the tube, and the velocity of the flow of nitrogen through the tube is, therefore, not increased. (2) The temperature to which the pyrex glass is heated (not above 300°) is too low to soften the glass. The pyrex tube therefore is not subjected to severe thermal changes and will last indefinitely. (3) The temperature to which the nitrogen is heated may be made maximal. The nichrome coil may be heated to any temperature desired up to decomposition of the nichrome. From 400 to 600° is sufficient to insure a high degree of reactivity of the traces of oxygen so that the oxygen rapidly combines either with the nichrome or the copper gauze. (4) The temperature of the copper gauze is high enough to insure the rapid reaction with all traces of oxygen, but it is not sufficiently high to drive off the copper oxide which has been formed. The position of the gauze in contact with the pyrex glass tube insures the maximal conduction of heat from the copper through the glass. (5) The tube is made of light construction and is not bulky. This fact permits a convenient arrangement of the tube in connection with electrode cells. (6) All parts of the tube are visible and the condition of the tube can be checked up without difficulty.

The first four points which have been considered are in strong contrast to the conditions present in a pyrex glass tube filled with copper wire and heated by an outside furnace. In such a furnace the velocity of the gas through the tube is high because of the bulk of copper. The pyrex glass tubing is subjected to great thermal changes. It may be ballooned out by pressure of the gas or collapsed due to a vacuum which may be produced in the system. The oxygen in the nitrogen is heated to a sufficiently high degree to react with the copper, but copper oxide is readily decomposed into copper and oxygen at a temperature which is sometimes used in this type of furnace.

With the new type of furnace the volume flow can be raised to 500 cc a minute and the copper oxide does not form for a distance of more than 4 cm from the entrance end. Even after 24 hours, not more than 15 cm of the gauze will be tarnished with the oxide. The reduction of the copper oxide with hydrogen requires but a few minutes.

Continued use of the furnace brings about changes in the properties of the copper. It looses ductility and becomes highly reactive to oxygen. If air at

laboratory temperature is passed through the tube, the copper becomes tarnished. When first prepared and at occasional intervals it is best to oxidize the copper with a rapid current of air through the tube while it is heated. This appears to burn off oil and other substances which cover the surface of the copper. The copper oxide formed is then reduced with hydrogen. This results in an enormous increase in the surface of the copper because of the cracked and seamed surface of the copper oxide. Reduction with hydrogen does not greatly change the physical appearance of this surface.

The removal of traces of oxygen from nitrogen in such a tube is complete. In addition the tube provides the solution of another important problem. It is possible to pass water vapor through the tube without the formation of even traces of hydrogen. Even if the water vapor is decomposed on the surface of the nichrome wire, the presence of the copper oxide completely removes all traces of the hydrogen so formed. All traces of hydrogen originally present in the nitrogen are removed as completely as is the oxygen.

In connection with studies of the oxidation reduction potentials of cysteine, an apparatus was prepared which consisted of eight electrode cells and two movable burettes, essentially similar to those described by Clark and coworkers.[4] Experience with such an apparatus over a course of several years has shown that deKhotinsky cement seals are frequently the source of contamination of the nitrogen with oxygen. Copper tubing, for the distribution of the nitrogen to the cells and burettes, also has been shown to be unsatisfactory. It therefore became necessary to modify the apparatus in order to make available a continuous source of nitrogen free from oxygen.

As it is desirable to see the contents of the electrode cells, the eight cells and the new type of copper gauze furnace which has been described were mounted on a framework which was counterbalanced and could be raised and lowered into the oil thermostat. Pyrex glass tubing connected the copper furnace to a distributor with eight pyrex stopcocks which terminated in pyrex tubing 8 mm in diameter. The eight delivery tubes from the distributing tubes fitted into eight mercury seal cups which were attached to the eight tubes that delivered the nitrogen to the electrode cells. A "Y" tube was placed in the distributing line and the nitrogen was connected to the two movable burettes by means of flexible copper tubing, 6 mm in diameter. Since copper tubing may be the source of contamination with oxygen, the nitrogen was passed through another small copper gauze purification furnace which was placed at the entrance of each burette.

[4] Hygienic Laboratory Bulletin No. 151, p. 35 (1928).

A diagram of this furnace is shown in Fig. 1. Continuous pyrex tubing connected this furnace with the movable burette.

In addition to these precautions for the removal of oxygen, the construction of the electrode cell was also modified. The tops of ten ounce nursing bottles were ground off on a steel plate with emery powder so that the top of the bottle was in one plane, parallel with the bottom, and presented a broad ground glass surface. Circular Bakelite caps, one cm in thickness, with flat-bottomed circular grooves which fitted the tops of the ten ounce bottles were held in place with a suitable frame which extended around two sides and across the bottom of the cell (Fig. 2). The bottle was

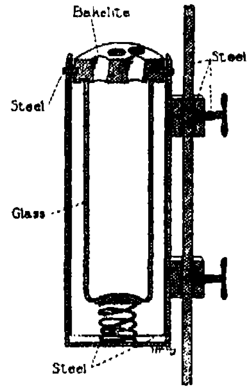


FIG. 2

securely held in the frame by a spring which pressed the cell against the Bakelite top. When vaseline was placed in the groove of the Bakelite top and the nitrogen outlet was closed, the vaseline seal between the ground glass top of the cell and the Bakelite top would withstand a pressure of 2 kilos. Through the Bakelite top, the electrode, the nitrogen inlet, the agar salt bridge and the nitrogen outlet were all arranged by means of tapering aluminum collars. The taper of the aluminum collar precisely fitted the taper in the hole through the Bakelite. The aluminum collars were fastened to the respective glass tubes with deKhotinsky seal and vaseline was used between the aluminum collar and the Bakelite top. The nitrogen outlet was also arranged to provide the inlet for addition of solutions from the movable burettes. This arrangement has two great advantages. First, it removes an opening in the Bakelite top, and, second, nitrogen continually passes around the tip of the burette and rapidly removes all traces of oxygen which may possibly have gained entrance to the outlet tube when the rubber stopper to this opening was removed. If the tip of the burette is placed in the nitrogen outlet and allowed to remain for one half minute or so before addition of the solution to the cell, the nitrogen will rapidly sweep out all traces of

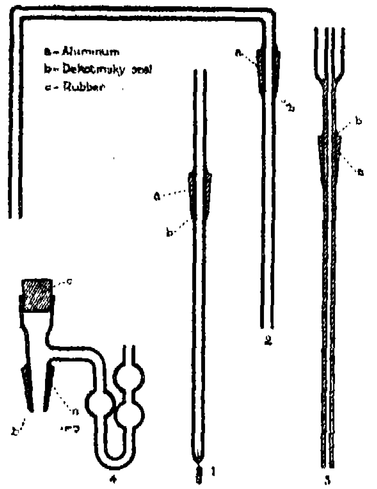


FIG. 3

oxygen. DeKhotinsky seals made as described are much more secure than if made without the collar of metal. Any other suitable material could be used in place of aluminum; this metal is easy to work on the lathe and has been found to be satisfactory in every way (Fig. 3).

Evidence that the copper furnace completely removes all traces of oxygen and that the construction of the electrode cells and movable burettes satisfactorily meets all requirements will not be included in this paper, but will be given in the papers dealing with the reaction of cobalt salts with cysteine, and the oxidation reduction potential of cysteine and glutathione.

E. C. KENDALL

MAYO FOUNDATION,
ROCHESTER, MINN.

SPECIAL ARTICLES

THE CHEMICAL CHANGES THAT OCCUR DURING THE CURING OF TOBACCO LEAVES[1]

IT has long been assumed that the metabolism of excised leaves follows a relatively normal course for quite appreciable periods of time, and that differences that arise between the chemical composition of such leaves and the intact leaf are due to the cutting off of the food supply from the stem and to the interference with the outlet for the products of metabolism; storage of these products therefore occurs. Subsequently, however, the changes become more patently katabolic; extensive dehydration of the tissue takes place if water is not supplied and this brings in its train a whole series of complex changes, many of which can be recognized as the results of the activity of well-known types of enzymes.

The curing of tobacco under commercial conditions affords an excellent opportunity for the study of these katabolic changes, since the soluble substances in the large thin leaf of this plant can be readily extracted by means of hot water and adequate quantities of leaves of uniform size and development are easily secured.

In order that definite comparisons might be established between leaf tissue which had reached different stages of the curing process five 50 kg lots of leaves (8th to 11th leaf) were picked from the plants the same day (August 1, 1929). One of these lots was immediately extracted with boiling water, the other four lots were strung on cords in the customary manner and suspended in a curing shed. The second lot was removed and extracted at the expiration of 12 days when all the leaves had become yellow, the third lot at the expiration of 18 days when the leaves had first become a uniform brown color, the fourth at the end of 51 days when the leaves were pronounced "fully cured," and the last lot was subsequently fermented along with the main crop of tobacco from the same field. Each lot was extracted with hot water in the same way. The leaves were dropped slowly into a large volume of boiling water to which sufficient sulphuric acid was added from time to time to maintain the reaction at or near pH 4.0; loss of nicotine was thereby avoided. After boiling until the mid-ribs were soft the leaves were pressed at the hydraulic press. The residues were then ground in a meat grinder and re-extracted with boiling water. This process was repeated once more. The three successive extracts were collected quantitatively, were filtered and concentrated *in vacuo* to 8 l. Analyses of extracts and extracted residues were then carried out, the methods for total, ammonia, amide and nitrate nitrogen employed being those recently developed in this laboratory,[2] amino nitrogen was determined by Van Slyke's method and the total solids, ash, crude fiber, soluble carbohydrate and ether soluble solids were determined by standard methods.

Inasmuch as each lot of leaves was initially of the same weight and the leaves were individually of the same size[3] and age, comparison between the different lots could be established by calculation of the absolute

[1] The expenses of this investigation were shared by the Connecticut Agricultural Experiment Station and the Carnegie Institution of Washington, D. C.

[2] H. B. Vickery and G. W. Pucher, *J. Biol. Chem.*, 83, 1 (1929); *Ind. Eng. Chem., Anal. Ed.*, 1, 121 (1929); G. W. Pucher, C. S. Leavenworth and H. B. Vickery, *Ind. Eng. Chem., Anal. Ed.*, 2, 191 (1930); H. B. Vickery and G. W. Pucher, *J. Biol. Chem.*, 90, 179 (1931).

[3] The uniformity of the material is evident from the fact that the 12-day lot contained 2,014 leaves and the 18-day lot contained 2,011.

weight of each component at each stage of curing. Loss or gain of any component could then be readily determined. This method of calculation gives results that are much more easily appreciated than those founded on a percentage basis since the total solids and total nitrogen, which are customarily employed as the fundamental data, both underwent substantial changes.

After completion of the curing process the 50 kg of fresh leaves weighed only 6.68 kg. By far the greater part of the loss of weight was due to the evaporation of water. The fresh leaves contained 43.53 kg of water and 6.47 kg of dry solids, the fully cured leaves contained 1.49 kg of water and 5.19 kg of dry solids, consequently 42 kg or 96.4 per cent. of the water originally present had evaporated. The magnitude of the loss of solids is striking. Approximately 1.3 kg or 19.8 per cent. of the whole disappeared, and this loss was found to fall exclusively, as might be expected, on the organic matter of the leaf. A detailed discussion of the types of substances that contributed to this lost material can not be attempted in this place[4] but the data strongly indicate that more than half of the material that disappeared had its origin in protein.

There were 426 gm of ether soluble material in the fresh leaves; after 12 days 347 gm were present and after 51 days only 260 gm remained. This represents a loss of about 39 per cent. of the initial quantity during the curing process. Much of the extensive early change in the quantity of ether soluble material present is probably associated with the destruction of the chlorophyll which was practically complete at the end of 12 days. The fresh leaves contained 92.5 gm of chlorophyll. On the assumption that decomposition to chlorophyllides and phytol occurred, two thirds of this amount should have been converted to substances of rather low solubility in ether at the time the chlorophyll was no longer recognizable in the leaf. During the entire curing process, however, other and quantitatively much more extensive changes also occurred. In how far these were due to conversions of ether soluble substances to ether insoluble substances rather than to direct loss from the leaf (*e.g.*, by evaporation) was not ascertained.

The amount of crude fiber in the leaves underwent no change, but the amount of soluble carbohydrate, estimated from copper reduction as glucose, diminished from 348 to 65 gm, a loss of more than 81 per cent. That a considerable part of this carbohydrate was either glucose, fructose or mannose was demonstrated by the isolation as phenyl-glucosazone of 48 per cent. of the indicated 348 gm of sugar in the extract from the fresh leaf. If it be assumed that all the loss of carbohydrate was due to oxidation to carbon dioxide and water, or other volatile substances, the quantity that disappeared accounts for only about one quarter of the total loss of organic matter during curing.

Of the 288 gm of nitrogen in the fresh leaves 105 gm were soluble in hot water but, during the first 12 days, enzymatic hydrolysis of coagulable protein occurred and the amount of nitrogen soluble in hot water was increased by 84 gm. Peptide nitrogen could not be demonstrated to be present in these extracts and it is therefore probable that the protein underwent complete digestion to amino acids. During the same period a rapid rise in ammonia and amide nitrogen took place, the sum of these increasing from 4.3 to 36.8 gm. Extensive deamination of the amino acids followed by amide synthesis must, therefore, have occurred. These observations are in complete agreement with those of Chibnall[5] on starved runner bean leaves.

The magnitude of the quantities of nitrogen involved in these conversions can best be appreciated from a consideration of the data for the whole curing period. The total nitrogen of the leaves decreased from 288 gm to 246 gm but evaporation of nicotine accounted for a decrease of only about 4 gm. The remaining 38 gm therefore represent nitrogen that escaped from the leaves in some other form of combination, in all probability as ammonia. Inasmuch as the nitrogen in the water insoluble residues of the leaves diminished from 182.8 to 72.5 gm, an amount of protein that contained approximately 110 gm of nitrogen was converted into a form soluble in hot water. Calculation from the sum of the ammonia and amide nitrogen present at the beginning and end of the curing process, with due allowance for the 38 gm of nitrogen that escaped from the tissues, showed that no less than 69 gm of nitrogen passed through the ammonia or amide nitrogen stage. While it is improbable that all this was originally in the form of protein and was derived from the 110 gm of nitrogen in the protein that was digested, it is evident that no less than 23.9 per cent. of the total nitrogen of the leaf passed through one or both of these stages. Deamination of amino acids and synthesis of amides are therefore of great importance during the curing of the tobacco leaf.

An approximate idea of the proportion of the original protein nitrogen that shared in these reactions was secured from a study of the amino nitrogen in the extracts and of the amino nitrogen yielded by the leaf residues after these had been subjected to

[4] A full discussion together with the complete data of this investigation will be presented in *Bulletin* 324, Conn. Agr. Exp. Sta. (1931), in press.

[5] A. C. Chibnall, *Biochem. J.*, 18, 387, 395 (1924).

complete hydrolysis. The difference between the amounts of amino nitrogen produced by acid hydrolysis of the residues at two successive stages may be regarded as a measure of the amino nitrogen which gradually passed into solution as the katabolic reactions in the tissues proceeded. The residues from the fresh leaves yielded 104 gm of total amino nitrogen, those from the leaves that had been cured for 12 days yielded only 53 gm, consequently in this period 51 gm of potential amino nitrogen must have passed into a soluble form. But, instead of a corresponding increase of 51 gm of amino nitrogen in the extract from the 12-day cured leaves, this increase amounted to only 26 gm; 25 gm of amino nitrogen disappeared as such. It was found, however, that the accumulation of ammonia and amide nitrogen that occurred amounted together to approximately 28 gm, which corresponds satisfactorily to the observed deficit of amino nitrogen. It is clear, then, that at least half the potential amino nitrogen of the protein that underwent enzymatic hydrolysis in the first 12 days was further converted to ammonia and amide nitrogen.

The approximate constancy of the quantities of ammonia, amide and amino nitrogen in the extracts from the more fully cured specimens of leaves suggests some sort of an equilibrium condition in the relationships between these forms of nitrogen. In the period from 12 to 51 days the sum of the three forms diminished by only 5 gm. The unassigned or "rest" nitrogen likewise diminished by about 5 gm in spite of the fact that, during this interval, some 23 gm of nitrogen, originally present in the form of coagulable protein, were converted to a soluble form. Extensive changes took place in the forms in which the nitrogen is combined in the leaves and the data suggest that, although many side reactions doubtless occurred, the *essential* sequence of reactions was, protein nitrogen $\rightarrow$ amino acid nitrogen $\rightarrow$ ammonia nitrogen $\rightarrow$ amide nitrogen. Whether the nitrogen that escaped from the tissues, presumably in the form of ammonia, was derived from subsequent hydrolysis of the amides or directly from the deamination of amino acids was not ascertained. Probably both sources were available since the presence in the leaves of enzymes that hydrolyze amides was suggested by the extensive decrease in amide nitrogen that ensued during fermentation of the fifth lot of leaves.

Perhaps the most significant result of these studies is the demonstration of the rapidity of the katabolic reactions during the early stages of curing. Three quarters of the loss of water and of soluble carbohydrate and more than half of the loss of organic solids and of ether soluble constituents occurred during the first 12 days; more than three quarters of the quantity of protein digested underwent this process in the same period. It is obvious that far-reaching chemical changes set in very shortly after leaves are detached from the plant.

HUBERT BRADFORD VICKERY
GEORGE W. PUCHER
CONNECTICUT AGRICULTURAL
EXPERIMENT STATION

POLLEN-STATISTICS: A NEW RESEARCH METHOD IN PALEO-ECOLOGY

THE number and importance of the papers on ecology in American botanical literature clearly testify to the popularity of ecology among American botanists. Yet the domain of Paleo-ecology has been almost untouched, although researches along such lines would, in many cases, lead to a better understanding of actual ecological problems. In Europe no other branch of Paleo-ecology has been more popular during the last years than pollen-statistics, or the method of tracing the history of the forests from the occurrence of the fossil tree pollen grains in peats and sediments, which was elaborated some twenty years ago by the Swedes G. Lagerheim and L. von Post. There are signs that an activity in this field similar to that in Europe is not far off in this country, and it has been considered appropriate, therefore, to give here a brief description of the working methods, together with some practical hints which might prove useful to beginners.

THE FIELD WORK

The field work is chiefly confined to the summer. During the winter, however, when the lakes are frozen over, samples of bottom sediments could be obtained by means of borings through the ice. Several types of boring rods are in use. The more obsolete ones are being supplanted more and more by the Hiller peat auger, manufactured by the Beus and Mattson Company of Mora, Sweden. This company offers the auger in two different models; a smaller one with extension rods of 100 cm each, which is kept in a leather case and carried by a strap over the shoulder, and a bigger one with extension rods of 150 cm each. The approximate cost of the two models is about twenty-five and forty-five dollars, respectively. If the field work is carried out with the help of an assistant, preference should be given to the heavier auger, which is more reliable than the smaller one. The field apparatus also includes a spade, a big knife, forceps, glass tubes in which to keep the samples (about 7.5 cm long and 1.3 cm inside diameter and corked at both ends), diopter compass, and a geodetical set for taking levels and distances.

At the boring place a big sod of the surface material is first removed with the spade. From the walls of the sod the first samples are taken, say, from 2, 5, 10, 15 and 20 cm below the surface. Then the auger

is put in the hole left by the sod, and forced down in the peat. Meanwhile the handle of the auger should be kept turning slightly to the right (clockwise) to prevent the opening of the container. Then the container is opened, and a good and compact core is obtained if the handle is turned, swiftly, about eight times (four revolutions), counter-clockwise. It is then closed by a couple of turns to the right, and the auger is pulled up out of the peat during a continued slight revolution to the right. Samples are taken with the forceps at regular intervals, *e.g.*, at every fifth cm, out of the core of the container, since the outer layer of the core, which might be contaminated, has been removed with the knife. The forceps should be nickeled and have smooth ends.

It is useful to have the spade standing nearby the boring place and to put the lower end of the auger with the container through its handle when the samples are taken. Fig. 1 shows, schematically, a

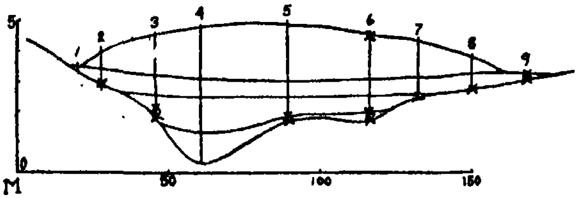


Fig. 1

section of a bog, the stratification of which has been made out from serial borings. A series of peat samples would most suitably be gathered from point 4, and additional samples for the study of the growth of the bog and the composition of the sub-recent pollen flora, etc., from the places marked with a cross.

The Laboratory Work

When preparations for microscopical investigation are to be made, a small amount of peat is taken from each end of the substance enclosed in a glass tube, laid on a slide and mixed with 10 per cent. caustic potash. The slide is held with a clothes pin and the mixture is carefully boiled over a small alcohol flame until the greater part of the water has evaporated. Some drops of glycerine are then added and mixed with the peat, and a part of the mixture is removed to another slide and covered with a cover-glass. The pollen-grains are then counted by the use of the micrometer stage of the microscope. A magnification of about 200 times is required, and then a high power lens for the study of the finer details of the exine. Some sediments need no boiling and preparations are simply made by mixing a part of the substance with distilled water. Calcareous material is treated with dilute hydrochloric acid and minerogene earths, even rather coarse sand, could be subjected to pollen-analysis if centrifugated and treated with hydrofluoric acid.

Trustworthy percentages are obtained if about 150 pollen-grains are counted. The frequency of the pollen-grains of hazel, willows, and other species which are more or less confined to the under-growth of the forests, is calculated separately and expressed as a percentage of the sum of the pollen-grains of the forest trees proper. Thus, a willow pollen frequency of 138 per cent. indicates that the number of willow pollen-grains in that preparation was bigger than the sum of the pollen grains of the forest trees. The frequency of *Sphagnum* spores, tetrads of *Ericaceae*, etc., is expressed in the same way. It is useful, too, to have a record of the PF, or pollen frequency per square cm, from each preparation.

By means of the percentage figures, a *pollen-diagram* is constructed. The relative frequency numbers, which are produced for the pollen-species found in a sample, constitute the *pollen-spectrum* of the sample. On the basis of a series of pollen-spectra from a boring in a bog, a pollen-diagram may be constructed, with the depth of the peat as ordinate and the pollen percentages plotted down on abscissae corresponding to those levels from where the samples were taken. In a pollen-diagram the curves for the single species or for a group of species give both a visual representation of the composition of the pollen flora and the oscillations as regards frequency which have taken place reciprocally between the pollen-curves during the formation of a bog.

Great difficulties are often encountered in identifying the pollen grains. Illustrations should not be relied on, but everyone working with pollen-statistics should have access to reference preparations of pollen-grains from recent trees. Such preparations could be made directly from fresh material or from boiling stamens of herbarium specimens with 10 per cent. caustic potash and mounting the pollen grains in glycerine jelly. After some practice it would be possible also to identify pollen grains of different species within the same genus; for instance, to distinguish the pollen of *Picea canadensis* from the slightly smaller one of *Picea mariana*, that of *Pinus murrayana* from that of *Pinus banksiana*, etc. In some cases, complete variation statistical analyses must be made. As to *Pinus* and *Picea*, it might be useful to calculate and plot down in a reference table the limits within which the dimensions of the pollen grains vary. As in the preparations some pollen grains are only shown from above, obliquely, or contorted, or, even in mere fragments, as isolated wings, not only the breadth of the pollen grains should be measured, but also the height and depth of the pollen grain proper, and the breadth, height and depth of the wings.

Notes on the finer structure are desirable; also notes on the color, which might vary according to the chemicals used.

After the study of recent pollen grains, it would be advisable to search samples from the surface of the peat for pollen grains. The pollen grains found among the branches of living *Sphagnum* and in the moss cover of stumps and fallen trees give a picture of the composition of the contemporaneous pollen grains. That would give a key to the conclusions which can be drawn from fossil pollen in general, but, in this respect, too much care can not be exercised. We know, for instance, that pollen grains can be carried by wind for very long distances, so that coniferous pollen might be encountered in the peats of Greenland; and, further, that the pollen grains of some trees might be under-represented in the pollen-spectra, owing to their being distributed at a time when the lakes and the peat surfaces are still frozen, or from other causes are not as fit for catching and preserving the pollen grains as at a later season. Because the delicate *Populus* pollen grains may not be preserved in peat, it is understandable, too, that a virgin Cordilleran coniferous forest would produce somewhat the same pollen-spectra in the mountain bogs as do some of the poplar forests, with scattered conifers, in the muskegs of the Great Western Plains. I do not mention this to discourage any one wishing to take up pollen-statistics. Its renown as a good and helpful paleontological research method can not be jeopardized, as shown by its success in Europe. I only mention it because, in my opinion, a thorough study of the recent and sub-recent pollenflora of American bogs would be more valuable as a start for pollen-statistical investigations in America than the presumably rather hazardous task of identifying a multitude of pollen types from old deposits with material often much decayed and altered.

Further information on pollen-statistics can be obtained from the papers listed in "Literature on Pollen-statistics published before 1927" (Geol. Fören. Förh., 49, 196–211, Stockholm, 1927) and "Literature on Pollen-statistics published during the years 1927–1929" (ibid., 52, 191–213, 1930).

G. Erdtman

University of Stockholm

STRUCTURAL AND FUNCTIONAL VARIATIONS OF FIBROBLASTS IN PURE CULTURES

A medium has already been described[1] for the long-continued cultivation of mesenchyme cells under conditions which allow of very limited cell proliferation. Instead of the cells being fed upon the growth-promoting substances contained in embryonic tissue juice, they are treated with adult blood plasma. Cultures which are so nourished grow very slowly and can be kept in good condition over a much longer period of time than cultures which are allowed to proliferate at their maximum rate.

The experiments here reported have given additional information concerning the properties of cells as manifested under conditions of slow growth. The material consisted of various pure strains of mesenchyme cells which were isolated simultaneously from an embryo chick. These strains were derived from heart muscle, skeletal muscle, the perichondrium of cartilage and the periost of bone, respectively. Although these cell types exhibit striking differences in their nutritional properties,[2] it has not yet been possible to distinguish them morphologically. Until used for the experiments, which were made in flasks, the strains were carried by the hanging drop method on media favorable for the maximum proliferation of the various cell types. Each series of experiments was made at the same time from strains of the same age. Although regularly washed and treated with blood plasma, a number of cultures which have been allowed to remain in the same flasks for as long as one hundred days without being disturbed have continued to show appreciable growth over the entire period. In the case of those cell strains which become early adjusted to the plasma medium, growth becomes progressively more and more active from passage to passage. Sufficient heparin is added to the plasma to prevent its coagulation during each period of treatment. In the concentration used, appropriate experiments have shown, however, that the heparin has no appreciable effect upon the rate of growth of fibroblasts. When the cultures are subdivided and transferred, the new clots are allowed to coagulate spontaneously without the customary addition of tissue juices, and the same manner of treatment is resumed. Hence, we can definitely state that these cells are able to live and multiply at the expense of the food substances contained in the plasma alone.

It is undoubtedly true that the process of adaptation to the plasma treatment begins from the moment that the fibroblasts are transferred from an environment of ample food to one which is deficient in readily available food substances But while certain cell colonies are able to adjust themselves to the new environmental conditions without very pronounced structural changes in the cells themselves, it does not follow that this is always the case, even among sister

[1] A. Fischer and R. C. Parker, *Arch. f. exper. Zellforschung*, 8, 325, 1929.

[2] R. C. Parker, *Arch. f. exper. Zellforschung*, 8, 340, 1929.

cultures originating from the same strain. To illustrate: after the first series of experiments had been carried in the flasks under this treatment for about twelve days, it was noticed that the cells of one of the cultures belonging to a strain of fibroblasts derived from muscle had very suddenly given rise to a broad band of macrophages. A few days later a culture of the same age, but belonging to a strain of heart fibroblasts, behaved similarly. Less than two weeks later a third culture showed the same phenomena. This third culture, which had been treated for twenty-eight days in the flask when the transformation occurred, had been made from a strain of fibroblasts originating from bone periost, a strain which had been carried for twelve passages before the experiment was made. It was therefore quite obvious that the phenomenon was not limited to any one cell type. It is interesting to note that Carrel and Ebeling,[3] Fischer[4] and Ephrussi and Hughes[5] have reported the occasional occurrence *in vitro* of similar transformations, although the factors responsible for the changes have never been clearly defined.

After these and many similar observations had been made, new experiments were set up in an endeavor to duplicate as closely as possible every step in the treatment of these cultures in the hope that the changes might recur. And since this proved to be the case, we had a better opportunity for studying the predisposing conditions. Since, also, but a limited number of the cultures comprising the various experiments showed the phenomena, it was possible to make a comparative study of the general condition and rate of growth of cultures which had transformed and of those which had not. It was found that those cultures which had not transformed fell into two groups, namely, cultures which responded very favorably to the plasma treatment, as evidenced by the condition of the cells and their rate of proliferation, and those which could not adapt themselves to the new medium and very early succumbed when deprived of the abundant food substances which they had received before being placed under the conditions of the experiments. When transformation did occur, it seemed to take place at some critical period in the life of a culture in which the degeneration process was already quite evident, but was advancing at a relatively gradual rate.

These cells have been referred to as macrophages because they appeared identical with macrophages both in form and behavior. They were quite independent, very active, and showed no tendency to form a tissue. They also possessed the typical undulating membrane. Their origin was very easily ascertained. They were invariably budded off from the fibroblast-like cells at the periphery of a culture which showed unmistakable signs of degeneration. The cells from which the macrophages were derived were always very heavily granulated and distended. Several macrophages were usually pinched off from a single fibroblast, until finally nothing was left of it but a small remnant packed with the globules and granules of the original cell. When the transformation process had once begun, it continued with great rapidity. The macrophages wandered out into the medium at a uniform rate from the entire periphery, and, inasmuch as plasma is the optimal medium for their multiplication, they eventually covered an area which was, in some cases, twelve times as great as that finally covered by the colony of fibroblasts from which they were derived. The identity of the macrophages was further borne out by certain reactions, typical of blood and tissue macrophages, to alterations in the chemical constitution of the medium.

It seems reasonable to conclude that the macrophage and the fibroblast represent functional variations of the same cell type. The extent to which a cell changes its form depends, however, upon its physiological condition at any one moment and upon the chemical and physico-chemical properties of the medium. In order to determine the nature of such properties as may be responsible for these changes, it now becomes necessary to study the effect upon the cells of various constituents of the medium employed.

RAYMOND C. PARKER

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK, N. Y.

[3] A. Carrel and A. H. Ebeling, *J. Exp. Med.*, 44, 261, 1926.

[4] A. Fischer, *Arch. f. exper. Zellforschung*, 8, 345, 1926.

[5] B. Ephrussi and Y. Hughes, *C. R. de la Soc. de biol.*, 105, 697, 1930.

BOOKS RECEIVED

ESSIG, E. O. *A History of Entomology.* Pp. vii + 1029. 263 figures. Macmillan. $10.00.

FAJANS, KASIMIR. *Radioelements and Isotopes: Chemical Forces and Optical Properties of Substances.* Pp. x + 125. McGraw-Hill. $2.50.

HILLIARD, CURTIS M. *The Prevention of Disease in the Community.* Pp. viii + 193. 25 figures. McGraw-Hill. $1.75.

JEANS, SIR JAMES. *The Stars in Their Courses.* Pp. x + 173. 46 plates. Cambridge University Press. Macmillan. $2.50.

JORDAN, EDWIN O. *Food Poisoning and Food-Borne Infection.* Pp. xi + 286. 22 figures. University of Chicago Press. $2.50.

LINDSEY, ARTHUR W. *The Problems of Evolution.* Pp. xiii + 236. Macmillan. $2.00.

SARTON, GEORGE. *The History of Science and the New Humanism.* Pp. 178. Holt. $2.00.

SMAIL, LLOYD L. *College Algebra.* Pp. xv + 450. McGraw-Hill. $2.50.

STALLYBRASS, C. O. *The Principles of Epidemiology and the Process of Infection.* Pp. xii + 696. 104 figures. Macmillan. $8.50.

SCIENCE

VOL. 73 FRIDAY, APRIL 17, 1931 No. 1894

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

INDIVIDUAL DIFFERENCES IN HUMAN BLOOD[1]

By KARL LANDSTEINER, M.D.

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

BECAUSE of the difficulties in working with substances of high molecular weight, one is as yet far from the goal of chemically characterizing the single proteins and determining the constitution of these substances, which rank as the most important components of living matter. Hence it was not the use of the ordinary chemical methods, but the application of serological reagents, which led to an important general discovery in protein chemistry, namely that the proteins in various animals and plants are different and are specific for each species. The multiformity is increased by the fact that also various organs contain particular proteins. It thus would appear that in the case of living organisms, special structural substances are required for each single form and function, in contrast to artificial machines, which, serving the most diverse purposes, may be constructed from a limited number of materials.

The discovery of biochemical species specificity prompted the question which formed the basis of the investigations about to be discussed, as to whether the specific differentiation goes beyond the limits of species, and whether also the individuals within a species show similar, though presumably slighter, differences. As no observations whatever were available pointing to such behavior, I chose the simplest amongst the possible plans of investigation, and that material which gave promise of useful application. Accordingly, the investigation consisted of allowing blood serum and red blood corpuscles of different human individuals to interact.

The results were only partially those that had been expected. In many tests, just as if the blood cells had been mixed with their own serum, no changes were

[1] Nobel Lecture read in German at Stockholm, December 11, 1930.

observed. Frequently, however, a phenomenon described as agglutination occurred, the serum causing a clumping of the cells of the other individual.

The unexpected feature was that the agglutination, when it did occur, was as marked as the well-known reactions in which serum and cells of different animal species interact, whereas in other cases there seemed to be no difference in the blood of various individuals. At this point it was still to be considered that the phenomena observed did not signify the individual differences sought for and that the reactions, though obtained with the blood of healthy individuals, might have been due to a past history of disease. It soon became evident, however, that the reactions followed a law which holds for the blood of all human beings, and that the properties observed are as characteristic for single individuals as are the serological properties distinguishing species. There are in the main four different kinds of human blood, constituting the so-called blood groups. The number of the groups depends on the existence in the erythrocytes of substances (isoagglutinogens) having two different structures, either or both of which may be present or absent in the erythrocytes of a given person. This alone would not be sufficient to explain the reactions; the active substances of sera, the isoagglutinins, must also occur in a definite distribution. Such is indeed the case, for every serum contains those agglutinins which act upon the agglutinogens not present in the cells, a remarkable phenomenon, the cause of which has not yet been definitely established. From these facts there follow definite relationships, shown in the table below, between the various blood groups, which make the task of their determination a simple one. The groups are designated according to the agglutinogens contained in the cells. (In the table the sign + indicates agglutination.)

Serum of group	Agglutinins in serum	Erythrocytes of group			
		O	A	B	AB
O	$\alpha\beta$	–	+	+	+
A	β	–	–	+	+
B	α	–	+	–	+
AB	–	–	–	–	–

The question will now be asked whether isoagglutination is limited to human blood, or occurs also in that of animals. As a matter of fact, such reactions are found among animals, but they are definite only in the case of certain species, and are hardly ever as consistent as in the case of man. Only the highest anthropoid apes—the blood cells of which are indeed distinguishable from those of man, the proteins as yet not definitely so—have blood group characteristics which, as far as has been investigated, are shown to coincide completely with those of man. It may be assumed that the comparative study of numerous animal species will serve to elucidate the phenomenon of group formation, which is not yet completely understood.

A noteworthy piece of work with respect to animal blood is already at hand. Very soon after the first observations on isoagglutination had been made, Ehrlich and Morgenroth described experiments in which they demonstrated variations in the blood of goats by the use of hemolytic antibodies—the isolysins—which were formed when the animals received injections of blood from other individuals of the same species. No typical blood groups were observed, but rather numerous apparently irregular differences, a finding which, apart perhaps from the intensity of the reactions, is about what might have been expected on *a priori* grounds. Similar investigations, particularly those of Todd on cattle and fowl,[2] pointed to almost complete individual specificity.

The apparent discrepancy between the observations made on man and the lower animals has recently been explained. Some suggestive observations having been reported previously, I was able, with Levine, to obtain definite results with the aid of special immune sera produced by injecting rabbits with human blood. This work led to the detection of three new agglutinable factors present in all four blood groups. Thus it could be established that there are at least 36 different types of human blood, if one also takes into account the subdivision of groups A and AB each into two subgroups,[3] which has been studied recently in my laboratory and thoroughly investigated by Thomsen. Furthermore, it could be demonstrated that iso-reactions of lesser intensity,[4] which do not follow the group rule and vary in their specificity, are more frequently found than was formerly supposed. As these irregular reactions can without difficulty be distinguished from the typical ones, they do not in the least invalidate the rule of the four blood groups. On the basis of these results we may assert that in the case of man there are numerous individual blood differences already demonstrated, and undoubtedly there exist still others which have not yet been established. Whether actually each individual blood possesses a special quality, or how frequently there is complete correspondence with the blood of others, can not be definitely stated at present.

These findings have, at the present time at least,

[2] Landsteiner and Miller, Todd.

[3] S. v. Dungern and Hirschfeld, Guthrie and collaborators.

[4] Unger, Guthrie and collaborators; Jones and Glynn; Landsteiner and Levine.

no special significance in the therapeutic application of the blood groups; they are, however, probably related closely to an important field of surgery, namely, that of the transplantation of tissues.

It has long been known that transplantation—for instance, of the skin—is much more successful when the transplanted tissue is that of the same individual, and this is also true of tumors transplanted to various strains of a species, as first described by Jensen. The experience of surgeons is confirmed by animal experiments, among which the important series of L. Loeb is especially noteworthy. His experiments consisted of the transplantation of different tissues—from the same individual, from those having blood relationship, from those not so related or belonging to different varieties and species. In general the success of transplantation stood in a reciprocal relation to the degree of consanguinity, and a review of all the findings permitted the conclusion that the tissues of a single individual must possess special biochemical properties.

The agreement between the results of the two independent methods is so striking that one is immediately led to assume that there are differences of substantially the same kind which, on the one hand, determine the individual variations detectable by means of serum reactions, and on the other, the individually specific behavior of transplants. As a support for the assumption it may be cited that the group characteristics, besides being present in the blood, can also be demonstrated in the cells of organs. On the basis of this theory, *i.e.*, taking into account the blood groups, it has been attempted to make tissue transplantation more successful; such efforts, however, have not led to consistent results. But this is understandable, for the blood groups constitute only a part of the existing serological differences, and even apparently slight deviations may influence the take of the transplant. Consequently, the difficulty that arises from the experiments may seem to be disposed of, and the most probable supposition would be that the two series of phenomena—the serological differences of the individuals and the transplantation specificity—are related in nature and depend on chemical differences of a similar sort. Hence there still remains a possibility that serum reactions may be employed in the future for the important problem of transplantation, although the knowledge available at present justifies no more than a hope in this direction.

Turning now to the question of the chemical nature of the substances underlying individual specificity, the answer, although almost wholly in the negative, is not without interest. The above-mentioned precipitin reactions, which revealed the species differences of proteins, were so impressive that the belief arose that proteins or related substances form the substrate of all serological reactions. This view was first disturbed by studies made on blood antigens. The solubility of specific substances in organic solvents, and particularly the investigations of the heterophile antigens of sheep blood, and organs of diverse animals discovered by the Swedish pathologist Forssman, which on extraction with alcohol yield a substance that is specifically binding but does not act as antigen, led me to the opinion that those parts of many cell antigens which determine their specificity are not albuminous substances, and that these fractions do not become antigenic until they are combined with proteins to form what may be conveniently called "complex antigens." A strong support for this view was found in the fact that it was possible by admixture with albuminous solutions to restore the antigenic power of the specific substance.[5]

Analogous results were obtained from the study of certain specific substances contained in bacteria (Zinsser). While for bacteria the chemical nature of the specific binding substances, or haptens, could be established with certainty—one deals in this case with colloidal polysaccharides (Avery and Heidelberger)—we do not yet possess definite information on the animal cell antigens. Nevertheless it may be stated that the biochemical characteristics of animal species are based on the existence of two diverse classes of species specific substances[6] which exhibit essential differences in the manner of their appearance.

What directly concerns our subject is the fact that group specific substances may also be extracted by alcohol from the blood corpuscles, and in general permit the formation of antibodies in this state only when mixed with antigenic proteins. We may, therefore, conclude that the haptens vary within a species, while analogous serological differences of proteins, although suspected, can not be definitely asserted. Another peculiarity is the fact that haptens which show relationships according to their reactions frequently are encountered in animal species widely separated in the zoological system. Thus isoagglutinogen A is serologically related to Forssman's antigen present in sheep blood, and for that reason certain immune sera react with sheep blood and with human blood of groups A and AB, but not with blood of groups O and B (Schiff and Adelsberger). Even more remarkable is the occurrence of similar structures in bacteria, which is shown by the presence of sheep lysins and apparently anti-A agglutinins in some antibacterial sera. This seems to be the case with

[5] Landsteiner and Simms.

[6] Landsteiner and Van der Scheer, Bordet and Renaux.

some anti-paratyphoid B immune sera, and a dysentery serum, recently described by Eisler, agglutinates human blood, and contains antibodies acting to a higher degree upon that one of the two subgroups of group A, which is less sensitive to the isoagglutinins.

The occurrence of isoantibodies showing individual differences is probably attributable, according to the results of investigations made on artificial complex antigens, to the fact that, through combination with other substances, proteins derived from the immunized species are capable of stimulating the formation of antibodies. If, on the other hand, haptens identical or closely related to those of the animal are injected in combination with foreign proteins, as a rule no antibodies are formed. As an example may be cited the experiments made by Witebsky, which demonstrated that group specific immune sera are formed after the injection of blood A only in the case of such rabbits whose organs do not contain substances similar to agglutinogen A. But that no definite rule can be set down is demonstrated by the experiments of Sachs and Klopstock on the appearance of the Wassermann reaction in rabbits after the injection of foreign serum mixed with alcoholic extracts of rabbit organs.

While in this instance the antibodies react only with organ extracts, O. Fischer, by injecting rabbit blood extracts mixed with foreign serum into rabbits, succeeded in producing autoantibodies which acted upon intact blood cells, and which were active hemolytically only after cooling, in a manner similar to the hemolysins which I, in collaboration with Donath, found to be the cause of hemolysis in paroxysmal hemoglobinuria. These results and the diversity of the immune sera produced with extracts of O and B red blood cells, and on the other hand with intact cells, point to the conclusion that the form of union of the substances within the cells also exerts an influence upon the antigen characteristics.

Following these brief remarks on individual blood differences and peculiarities of the cell antigens, we turn now to a discussion of the application of the group reactions. A voluminous literature, almost impossible of complete review, treating of the relative frequency of the individual blood groups among the various races of man, has come into existence since L. and H. Hirszfeld made the remarkable observation that in this respect there exist characteristic differences among the various races. Their most important finding was that the characteristic A is more frequently found among North Europeans than is the characteristic B, whereas the conditions are reversed among a number of Asiatic races. Another striking example is that the American Indians, when they are of pure race, belong almost exclusively to group O,[7] from which it is concluded that the occasional appearance of factors A and B is attributable to racial mixture.

To discuss the results of the anthropological investigations made on blood groups, and the conclusions derived therefrom, is beyond my province; the viewpoints of the various authors concerning the general principles and the individual problems are not in general accord. But there seems to be a prevailing belief that the behavior of the blood groups, in conjunction with other anthropological factors, may serve as an indicator of blood relationship and the descent of the races of man, and has, therefore, some anthropological significance.

A practical use of the group characteristics offered itself immediately for application in the differentiation of human blood stains for forensic purposes. With the aid of the precipitin reactions[8] it is not difficult to determine whether a certain blood stain is of human or of animal origin; but it was impossible for the forensic physicians to distinguish blood stains from various individuals. Since the isoagglutinins and the corresponding agglutinogens are preserved for some time in a dried state, the problem may be solved in certain cases, when the bloods to be examined—for instance, that of the accused person and that of the victim—belong to different blood groups. The occasions for employing the method are naturally not very frequent, and particularly in your country there is fortunately small opportunity for its use in this connection; but according to a report by Lattes, who was the first to apply the method in forensic practice, it has proved useful in a number of cases and has served as the basis for legal decision, sometimes as a criterion for establishing the innocence of the accused.

The group reactions have been employed far more extensively in forensic medicine in cases of disputed paternity. The possibility of making such decisions rests on the studies of the inheritance of the blood groups. The most important findings along this line we owe to v. Dungern and Hirschfeld. In their investigation they were able to determine that the two agglutinogens A and B are hereditary dominant properties, the inheritance of which follows the Mendelian law. The significance of this discovery lies in the fact that in the case of man there is hardly another physiological characteristic which can be so unequivocally demonstrated, and which at the same time follows so simple a rule. The genetic hypothesis of two independent pairs of genes, proposed by the above authors, had to be abandoned as the result of

[7] Coca, Snyder.

[8] Kraus, Bordet, Uhlenhuth.

the statistical work of Bernstein. On the basis of a definite gene hypothesis and on the premise of an adequate mixing of a certain population, it is possible to make calculations on the frequency of the inherited characters. A calculation of this kind was made by Bernstein, who found that the observed numbers and those calculated according to the hypothesis proposed by v. Dungern and Hirschfeld were widely divergent. On the other hand, there was complete agreement when the calculations were based on a hypothesis which postulates three allelomorphic genes in a certain locus of a chromosome. The assumption leads to definite expectations with respect to the children of AB parents, and these have been satisfied by the investigations of Thomsen, Schiff, Snyder, Furuhata and Wiener, with the exception of rare instances, which may possibly still be reconciled with Bernstein's theory. Hence the new theory has been almost universally accepted.

In forensic application, the dominance rule of factors A and B is standard. Hence paternity is excluded in all such cases in which a child is shown to possess A or B, when these characteristics are absent in the case of the mother and in that of the putative father. The test is quite frequently employed in several countries, particularly in Germany and Austria, and also in Scandinavia. In a review made last year by Schiff, he reports on about 5,000 forensic investigations, with 8 per cent. of excluded paternity, while according to a calculation there would be the possibility of such exclusions in 15 per cent. of the cases. In favor of the method it may be stated that it has also contributed to the recognition of illegitimate children by their fathers.

It may be of interest to indicate a further possible development in the decision of paternity. The preliminary results[9] obtained with two of the abovementioned blood properties demonstrated by immune sera point to the probability that their appearance is conditioned by a pair of genes, neither of which is dominant over the other, so that when both are present there results a mixed type. The existence of three phenotypes, M + N −, M − N +, and M + N +, is explained in that the last corresponds to the heterozygous, and the first two to the homozygous forms. Accordingly, the heterozygous form can be recognized directly. The implications of the hypothesis are shown in the next table.

According to our observations, there were some exceptions to this rule, which prevented our final acceptance of the hypothesis. It is possible, however, that these exceptions are to be attributed to illegitimacy or to imperfections of the method of investigation, which is not as simple as that of the group

[9] Landsteiner and Levine.

Marriages	Progeny to be expected		
	M + N +	M + N −	M − N +
M + N + x M + N +	50	25	25
M + N + x M − N +	50	0	50
M + N + x M + N −	50	50	0
M + N − x M − N +	100	0	0
M + N − x M + N −	0	100	0
M − N + x M − N +	0	0	100

determination; recently Schiff in his published observations on inheritance and population statistics was able to show complete agreement with the theory. Almost equally satisfactory are the recent unpublished results of Wiener.

If on further investigation the hypothesis should prove to be correct, the possibility of excluded paternity would be almost doubled, and a determination might be feasible in about a third of all cases. On the basis of the present data, it is, however, possible already to make statements having a considerable degree of probability. Further development may result from the inclusion of the subgroups of groups A and AB (Landsteiner and Levine, Thomsen), if additional observations confirm the supposed regularities.

The blood group reactions are more significant for practical medicine, in the case of transfusion. It would take us too far afield to enter more deeply into the history of transfusion, a history going back hundreds of years, to the time of the discovery of the blood circulation by Harvey. The possibilities of the operation were conceived even before that time, but, stimulated by Harvey's great discovery, it was first successfully carried out by Lower on dogs in the year 1666 in England, and during the following year the first transfusions of blood from animals to man were made by Denys in France, and Lower and King in England. Further efforts were directed toward the invention of special apparatus, and it was learned that it is not necessary to transfer the blood from vessel to vessel, but that also defibrinated blood may be used (Bischoff 1835). The first transfusion with human blood was probably made by Blundell during the first half of the 19th century.

How differently the operation was regarded may be illustrated by two points of view, cited by Snyder. In a "History of the Royal Society" (1607), Sprat stated: "Hence arose many new experiments, and chiefly that of transfusing blood—that will probably end in extraordinary success." Again, in a "History of the Royal Society" by Thompson (1812) it is stated: "The expected advantages resulting from this practice have long been known to be visionary." Not-

withstanding all the efforts made, and the lively discussion of the problem, it was not possible to incorporate the procedure into medical practice, and the thought of its use had finally to be abandoned because the operation, while proving very useful in some cases, in others resulted in symptoms severe in character and even in death.

So far as the injection of animal blood was concerned, an explanation of the accidents was given by Landois, who as far back as 1875 discovered the phenomena of agglutination and hemolysis, which frequently took place when human blood was brought into contact with serum obtained from a foreign species. But it remained a mystery why the introduction of human blood into the circulation of man was at times dangerous, as it was considered a matter of course that the serum or plasma of the same species represents an innocuous medium, an assumption which was probably strengthened by the use of such sera in histological investigations.

The simple solution of the problem came in the discovery of individual blood differences and of the blood groups. Animal experiments, and particularly clinical experiences in cases where errors had been made in the determination of the blood groups, are confirmatory and leave no room for doubt that the transfusion of agglutinable human blood is, as a rule, accompanied by untoward consequences. The pathogenesis of shock following transfusion has, however, not yet been fully explained.

The first blood transfusion made on the basis of the agglutinin reaction was that of Ottenberg, but it was not until there arose the great need created by the world war that the method of transfusion from serologically selected donors was employed on a large scale and became definitely established.

It is not possible here to enter into details, such as the sources of error possible in the group determinations, their control through direct comparison of the recipient's with the donor's blood, and the precautionary rule of beginning the operation by the injection of small quantities of blood. It may, however, be mentioned that it is not absolutely necessary to employ blood of the same group, for we may also use other blood, for instance that of group O (see Ottenberg)—the cells of which are not influenced by the serum of any recipient. In the latter instance, however, it is necessary as a measure of safety to exclude donors with a high titre of agglutinins in their serum, as these may prove dangerous especially for severely anemic or weakened patients. The employment of the so-called "universal donors" of group O, or in general the use of inagglutinable blood of another group, may in an emergency and in the case of recipients belonging to the rare blood groups, be of great value.

Of the conditions indicating the employment of blood transfusion, the most important are acute and chronic anemia, that resulting from wounds, lung hemorrhages, in obstetrical practice, from tumors of the stomach and the intestines. The life-saving effect often produced in the case of hemorrhages is in the first instance of course attributable to blood replacement, and it is to be noted in this respect that the introduced erythrocytes may retain their function in the circulating blood over a period of weeks. Of significance also are the stanching of blood by raising the coagulability and probably the stimulation of blood regeneration in the bone marrow, as shown by changes produced in the histological blood picture. The great use made of blood transfusion in pernicious anemia has now become largely unnecessary through the discovery of liver therapy.

Another extensive field of application is in shock following severe injuries and operations. It is thought that in these cases the introduction of blood has a better effect than the injection of isotonic solutions, such as the common salt solution containing gums, employed by Bayliss during the war. According to these indications, apart from the blood replacement, transfusion can be employed with good results as a stimulant following major operations; in the case of weakened patients, American surgeons recommend its use even before severe operations.

Good results have also been obtained in haemophilia, thrombopenic purpura, and to a certain extent in agranulocytosis, CO poisoning, burns, while in a number of other diseases, for instance, the septicemias, in which transfusion was tried, the results have been uncertain.

Some figures which I presented before the International Microbiological Congress in Paris indicated the frequency of the use of transfusion therapy and the degree of comparative safety that has been achieved in this procedure, a result which in part at least is attributable to the considerable advances made in surgical technique. These statistics are not in entire agreement, as some authors, in contrast to others, still report occasional accidents. As these differences are probably ascribable to the technique employed in the procedure, I feel justified in basing judgment on the favorable reports provided they include a large number of cases.

The frequency of the operation is surprisingly great, and possibly it has at times been employed too extensively. According to statistics for which I am indebted to Dr. Corwin, of the New York Academy of Medicine, during the year 1929 there were about 10,000 blood transfusions given in New York City. In a recent publication of Tiber from Bellevue Hos-

pital in New York there are reported up to July, 1929, more than 1,467 transfusions made there in three and a half years. Among these transfusions, there were two deaths, one resulting from an error made in determining the blood group, and the other, also possibly avoidable, in an emaciated infant belonging to group A which received blood from a so-called "universal donor" of group O. Three deaths out of 1,036 transfusions reported by Pemberton, of the Mayo Clinic, were the result of errors in the determination of the blood groups. In Kiel, as I was informed by Dr. Beck, in the course of five years there were 2,300 transfusions given without a single death. In from 2 to 3 per cent. of the patients there were symptoms such as chills and a rise in temperature, which were, however, not of a severe character. A case of Beck's, one of pernicious anemia, is noteworthy: during a period of three and a half years, the patient received a total of 87 transfusions without any serious consequences.

Notwithstanding the favorable aspect of these results, there are reported, as said above, in addition to slight disturbances, exceptional severe and even fatal accidents which may not be attributable to errors in technique. It is not probable that in these cases the blood differences as indicated by the atypical isoagglutinins play an important rôle, in which event such accidents might easily be avoided. Whether, as has been assumed, injury can be caused by a marked pseudo-agglutination by the recipient's serum has not been definitely ascertained. Some of the disturbances appear to be due to allergy to food substances present in the injected blood, while others were ascribed to the action of antibodies formed as the result of former transfusions. The problem as to whether or not there are individual differences in protein which give rise to antibody formation has not been sufficiently investigated.

On the whole, the results obtained up to the present time with transfusion therapy are very satisfactory, and we may hope that an intensive study of the cases showing an unfavorable outcome will help to assess the significance of the supposed causes and reveal perhaps unknown ones, so that the slight degree of danger still attending the use of transfusions may be almost entirely averted.

Apart from the solution of this practical problem there is the possibility of developments resulting from the study of the biological aspects of individual serological differences in general, and particularly from the elaboration of procedures for finer differentiation of human blood and a continuation of the genetic analysis of serological blood differences in man and animals considering, that as a result of similar studies, we very probably possess to-day, apart from the sex chromosomes, knowledge of at least two pairs of human chromosomes which are marked by distinct characteristics.[10]

OBITUARY

JOHN HENRY COMSTOCK

Born in Janesville, Wisconsin, on February 24th, 1849.
Died at his home in Ithaca, N. Y., March 20th, 1931.
Between these dates, the career of one who rose from poverty and pioneer hardship to world service and honor.

His father was a frontier teacher, who died when the lad was three years old, and left him and his mother to struggle with want. At sixteen he became a sailor on the Great Lakes. Once in the course of his sailing when at anchor in the port of Buffalo, he visited a bookstore and came upon a copy of Harris's "Insects Injurious to Vegetation." Here was something that interested him beyond anything he had ever read. The illustrations fascinated him; but the price was beyond his means. He went sadly away. But he could not forego the possession of this precious book. He borrowed the money and returned and bought it; and this book had a large part in determining his future career.

At the age of twenty, though largely self-educated he was ready for college, and he entered Cornell University. That was in 1869, its opening year. He chose Cornell because there he could work his way; also, it was to be a place where in the words of its founder, one could "find instruction in any subject." So he came to study entomology.

But there was then no entomology at Cornell. There was, however, a sympathetic teacher of zoology, Dr. Burt G. Wilder, who promised the young man that he might work with insects to his heart's content. Under such friendly guidance his real work in entomology began.

So well did he work that he soon had a reputation for expert knowledge of insects; and so contagious was his enthusiasm that in the spring of 1872—his junior year—thirteen of his college mates petitioned the faculty to permit him to give them a course in entomology.

The request was granted. His teaching of entomology at Cornell began in a little room away up in the square tower of McGraw Hall, a building that had been built in part by the labor of his own hands. Later a department was created for him and in White

[10] While in press, an article on the subject was published by F. Bernstein, *Zeitschr. f. ind. Abst. u. Vererbungslehre*, 57: 113, 1931.

Hall for more than a score of years he was training men from all over the world for service in entomology.

His combined research-room and office was adjacent to his advanced students' laboratory, and the door between was generally open. Nothing in either was too sacred for use in the other if needed. He loved to share with his pupils the joys of discovery, and they delighted to share in his enthusiasm. There was no pretense about him, no derogation of the work of others, no bickering with those in whose beliefs he could not concur. His methods were those of simplicity and directness and reverence for truth. One of his admonitions that is perhaps best remembered by those who did research work under his guidance was this: "Be sure you are right, and then look again."

In the year 1872 he studied under Dr. H. A. Hagen during the summer vacation at Harvard. In 1878 he married Anna Botsford. The year 1888–9 they spent together at the University of Leipzig. In 1879 he became for a few years entomologist for the federal government at Washington. He then returned to Cornell where he taught continuously until his retirement in 1914.

Meanwhile, he occupied his winters from 1891 to 1900 with the work of organizing the department of entomology at Stanford University, teaching at Cornell during the summer by mutual agreement between the two universities. And, as he had sent L. O. Howard ahead of him to Washington and left him there to continue in the service, so he took V. L. Kellogg with him to Stanford and left him there to carry on.

After his retirement came a dozen fruitful years, during which he rounded out his life as a productive scholar. He had previously published his "Manual for the Study of Insects," and had repeatedly revised it for many editions, and had made it the most generally serviceable entomological text-book of his generation. He had published also "How to Know the Butterflies" and "Spider Book." Now, when freed from classroom duties and office routine, he settled himself to put together in final form the ripe results of his chief entomological studies. First appeared "The Wings of Insects," and later "An Introduction to Entomology." His books were products of slow and steady growth, and they are his chief monument.

In his later years he was the recipient of many honors. His pupils established at Cornell University a Memorial Library of Entomology to bear his name. The Fourth International Entomological Congress made him an honorary member. He was an honorary member of the Entomological Society of London. He was a member of the Entomological Society of France and of the California Academy of Sciences. A number of American national societies—entomologists, naturalists, zoologists—claimed him a member, fellow and betimes president.

In his day he taught entomology to more than 5,000 students. Practically all of these at some time or other entered the hospitable Comstock home. All the entomological world knows how John Henry and Anna Botsford Comstock worked together for more than half a century; how they supplemented and aided each other; how common were their interests; and how mutual was their labor. All know, also, how generous was their hospitality. Many savants from foreign shores were their guests. Many struggling students found under their roof-tree a second home.

Mrs. Comstock preceded her husband into the Great Unknown by half a year. Their ashes rest in a grave under an oak tree on a knoll in Lake View Cemetery at Ithaca. Within the view are the towers of the university of which they were so large a part. Outspread beneath lies Cayuga Lake and the valley they loved, with its flat woods and winding water-paths that they explored together in the days of their youth. Round about are the rugged hills of Ithaca whose insect fauna they made known to the world through intimate records and beautiful illustrations.

Their influence lives on in the hearts of thousands. One of Professor Comstock's earlier pupils, Dr. Ephraim Porter Felt, well expressed what they all feel when on March 21 he wrote:

> A great teacher has passed and left an enviable record. Professor Comstock endeared himself in a most charming way to all of his students. He exercised a very profound influence in establishing teaching standards for entomology. His writings are admirable models for his successors. His life was an inspiration to all searchers for truth, and an exemplification of possibilities in this land of equal opportunity.

James G. Needham

MEMORIALS

The John Burroughs Memorial Association made April 4 the occasion for the annual meeting of the association this year and a birthday celebration in the auditorium of the American Museum of Natural History. The speakers were Professor Franklin D. Elmer, of West Hartford, Conn., and Dr. Clyde Fisher, curator of visual education and astronomy of the museum. The object of the association is the acquisition and preservation of Slabsides, the house of John Burroughs, and the fostering of his teachings as a naturalist.

At Bordighera, where Pasteur lived for several months, special ceremonies were held recently in his honor. The commemoration was attended by many Italian physicians, Frenchmen, Belgians, Americans and Jugoslavs, under the chairmanship of Professor

Forgue, of the University of Montpellier. Professor Nicola Pende, medical clinician of the University of Genoa, delivered the official address.

An International Fund is to be raised for the erection of a monument in Rome to Carlo Forlanini, who introduced the artificial pneumothorax treatment for pulmonary tuberculosis.

The *Journal* of the American Medical Association states that a medallion portrait and a tablet of steel have been affixed in the pavilion of the Hôpital Cochin, Paris, where Fournier devoted twenty years to research on syphilology. The tablet recalls his research on the use of bismuth in the treatment of syphilis and on vaccination by the buccal route. At the ceremonies held in connection with the event, Professor Brindeau, chairman of the committee that sponsored the erection of the tablet, traced the career of Dr. Fournier before a group of former pupils and friends.

RECENT DEATHS

Dr. Spencer Trotter, formerly professor of biology at Swarthmore College, died on April 11, in his seventy-second year. After teaching for thirty-eight years, Dr. Trotter retired in 1926.

Professor George Severance, head of the department of farm management and agricultural economics and vice-dean of the College of Agriculture, State College of Washington, Pullman, died on March 8. Professor Severance graduated from the Michigan Agricultural College in 1901, and in 1901–02 he was instructor in agriculture at that institution. In 1902 he went to the State College of Washington as instructor in agriculture and served at that institution in various positions of responsibility with only a little more than one year's interruption until his death.

Dr. John Anderson, known for his work on cerebro-spinal meningitis, died at Shanghai on March 30. At the time of his death Dr. Anderson was head of the division of medicine at the Henry Lester Institute for Medical Research, Shanghai. Previously he had been professor of medicine at Hongkong University and a Wandsworth Fellow of the London School of Tropical Medicine.

Dr. William C. MacIntosh, a student of marine invertebrates, formerly director of the museum at the University of St. Andrews, Scotland, has died, at the age of ninety-two years. Dr. MacIntosh had held positions on many government committees dealing with the shell-fisheries of the British Isles.

SCIENTIFIC EVENTS

THE CALCUTTA INSTITUTE OF HYGIENE AND PUBLIC HEALTH

An article in the *British Medical Journal* on March 28 gives a description of the newly established Institute of Hygiene and Public Health in Calcutta. The proposal to establish a School of Tropical Medicine in Calcutta and an Institute of Hygiene at Bombay was first made by Dr. Leonard Rogers in 1914. Six years later the Calcutta School of Tropical Medicine and Hygiene, in which teaching and research were combined, was opened. At that time a chair of hygiene was established, and a course of instruction arranged for the university diploma of public health, but this provision was soon seen to be inadequate. It was recognized there would be an increasing need, in all the Indian provinces, for specialists and workers highly trained in general hygiene, with knowledge and experience of Indian requirements. This need was emphasized by Major General J. D. Graham in his annual report as public health commissioner in 1925, and by Major General Megaw, head of the school. They discussed their plans with Dr. W. S. Carter, associate director of the Rockefeller Foundation, during his periodic tours of India and as a result the Rockefeller Foundation offered to meet the cost of acquiring the site, and to build and equip an institute on an assurance from the government that it would defray the cost of staff and maintenance after the building was handed over.

In July, 1930, a site was acquired, and building was begun in September. A constructional committee was appointed, consisting of the public health commissioner with the Government of India, the surgeon-general with the Government of Bengal, the chief engineer with the same government, the chairman of the Calcutta Improvement Trust, and the Accountant-General, Bengal. Lieutenant-Colonel A. D. Stewart, professor of hygiene in the Calcutta School of Tropical Medicine, was appointed director-designate of the new institute, and Lieutenant-Colonel A. A. E. Baptist, assistant director, to superintend the construction and equipment. It is expected that the building will be completed by the end of this year, and that the institute will be opened for work early in 1932.

The site of the institute practically adjoins the school, with which the building will harmonize in design and appearance. The plan is based on a unit room of 25 ft. by 21 ft. The building, which will be E-shaped and four-storied, the long limb being in the center, will accommodate six sections: (1) public health administration; (2) sanitary engineering; (3)

vital statistics and epidemiology; (4) biochemistry and nutrition; (5) malariology and rural hygiene; and (6) maternity and child welfare and school hygiene.

Each section will be staffed by a professor, an assistant professor, and laboratory or other assistants. As the chief object of the institute is to bridge over the gulf between the results achieved by pure research and their practical application to the community, its function will be primarily instruction. The subjects for the D. P. H., Part I, will continue to be taught at the Tropical School, but the specialized subjects in public health will be taken by the staff of the institute. The examination for the D.P.H. is conducted by the University of Calcutta, with which the new institute will be affiliated in due course. It is also intended to provide short post-graduate instruction in special subjects for public health workers desiring to pursue advanced study, and it is probable that the university will institute a higher degree or doctorate in public health science, which will require a year's training at the institute in some specialized branch. Special courses in child welfare and public-health nursing may be arranged for women graduates and nurses, respectively. The institute will be coordinated with the various aspects of practical hygiene and public health all over India.

FIELD EXPEDITIONS OF THE SMITHSONIAN INSTITUTION

According to a press release from the Smithsonian Institution field expeditions during 1930 touched upon every continent and many islands of the sea, besides visiting 23 states of the United States, according to its annual illustrated pamphlet, "Explorations and Field-work of the Smithsonian Institution in 1930," just issued. The subjects of investigation by these expeditions were as varied as the localities visited; they included the radiation of the sun, microfossils—those minute organisms of great value in determining oil zones in the earth's crust, the ancient Eskimo culture of Alaska, Indian music, the animals and plants of the interior of China, the birds of Spain, fossil horses in Idaho, silver minerals in Canada, the plants of South Africa and many other subjects. From all these expeditions, large collections have come in to the U. S. National Museum for study and in some instances for exhibition to the public.

Dr. Aleš Hrdlička devoted the summer months of 1930 to a study of the ancient and modern Eskimo population along the Kuskokwim River, the second largest in Alaska. This area has never before been visited by a physical anthropologist, and Dr. Hrdlička's work led to valuable conclusions.

In continuation of his "fossil horse round-up" in Idaho, Dr. J. W. Gidley spent the field season in working the fossil bone deposit near Hagerman, Idaho. The deposit was probably at the time it was formed a watering place for the wild animals of the region, for it contains the bones of hundreds of animals, mostly belonging to an extinct species of horse. This deposit is considered one of the important paleontological discoveries of recent years, for it contains abundant remains of the rare extinct horse, *Plesippus*, an animal intermediate between the present-day horse and the three-toed horse of more ancient time. Sufficient material was collected to restore three or four complete skeletons.

Lieutenant Henry C. Kellers, U.S.N., was detailed to act as Smithsonian representative on the U. S. Naval Observatory Eclipse Expedition to Niuafou Island of the Tonga Archipelago, in the South Seas. This island is commonly known as "Tin-can Island," for so rocky and precipitous is the shore that mail can only be delivered from the mail steamer by enclosing it in a sealed can and throwing the can overboard, where it is picked up by native swimmers and towed to shore. Dr. Kellers, with the aid of the natives, succeeded in collecting many of the unusual life forms of the island, over 7,000 specimens being sent back to the National Museum.

Twenty-nine separate expeditions of 1930 are described in the Smithsonian's publication. All are described in the words of the field-workers themselves and all are illustrated by photographs taken in the field.

MEETING OF THE NATIONAL ADVISORY HEALTH COUNCIL

The field and laboratory investigations being conducted by the U. S. Public Health Service were surveyed, according to the New York *Herald-Tribune*, on April 10, and generally approved by the National Advisory Health Council, a body consisting of internationally known authorities in various fields of scientific endeavor related to the work of the Public Health Service established recently under an act passed a year ago. It organized in executive session on April 9 and had its first meeting with members of the government staff.

Carrying out its function of talking over the research problems of government investigators and advising them, the members of the council heard members of the field force of the health service and of the staff of its national institute of health. The council replaces on an extended scale the old advisory board, which performed similar functions for the hygienic laboratory before it was made the nucleus of the national institute.

Its members include Drs. William H. Welch, of the Johns Hopkins University; Haven Emerson, of Columbia; C. E. A. Winslow, of Yale; M. P. Ravenel,

of the University of Missouri; W. H. Howell, of Johns Hopkins; Alfred Stengel, of the University of Pennsylvania; Captain C. S. Butler, U.S.N.; Colonel P. M. Ashburn, of the Army Medical Corps; Drs. John R. Mohler, of the Bureau of Animal Industry of the Department of Agriculture; George W. McCoy, director of the National Institute of Health; L. R. Thompson, assistant surgeon-general of the Public Health Service in charge of research, and Hugh S. Cumming, Surgeon General, chairman.

Cancer research, which is being conducted by the Health Service more extensively than ever before, was discussed with the council at some length. This work not only has been expanded under increased appropriations, but is to be extended further, and the government scientists asked the benefit of the council's advice in that undertaking.

Field work on leprosy, particularly in Hawaii, was also discussed, together with studies of malaria, Rocky Mountain spotted fever, which recently has invaded the east; child hygiene, industrial hygiene and sanitation, milk sanitation, stream pollution and statistical analysis of different public health problems.

Investigations discussed included work on certain phases of cancer, diphtheria prevention, meningitis, nutrition, infantile paralysis, scarlet fever, trachoma, tularemia, typhus, undulant fever, etc. Work on sociological problems, including studies of parasites and animal hosts, at the institute, and special chemical studies related to public health problems also were discussed.

RESEARCH AT THE MELLON INSTITUTE

In his eighteenth annual report to the board of trustees of Mellon Institute, Director E. R. Weidlein has summarized the activities of the institution during the fiscal year ended February 28, 1931. The sum of $805,204 was contributed to the institute by the industrial fellowship donors in support of scientific research. The total amount of money appropriated by companies and associations to the institute for the twenty years ended February 28, 1931, was $7,554,477.

Throughout the entire fiscal year 76 industrial fellowships—22 multiple fellowships and 54 individual fellowships—were in operation. During the preceding year the number of fellowships was 71. In 1930–31, 140 industrial fellows and 49 assistants held positions on the research staff. Sixty-four industrial fellowships (17 multiple fellowships and 47 individual fellowships)—three more than on February 28, 1930—were active at the close of the fiscal year. Nine fellowships are being sustained by industrial associations. The industrial research personnel consists of 109 fellows and 31 assistants. Thirty-one fellowships have been in operation for five years or more, and of this number 18 have concluded more than ten years of work. Three and possibly four new fellowships will begin operation during the early part of the present fiscal year—just as soon as laboratory space is available.

According to the report particularly noteworthy results have come from the following fellowships: Air pollution, by-product coke, face brick, fertilizer, heat-insulation, iodine, nitrogenous resins, organic synthesis, refractories, sleep and utensil. Twelve fellowships completed their research programs, namely, chrome ore, insulating lumber, Portland cement, composite glass, yeast, inhibitor, steel treatment, rock products, roofing, fatty acids (uses), oxygen and face brick. Thirteen new fellowships were added to the institute's roll during the fiscal year, as follows: Safety fuse, plastic composition, bread, cottonseed products, hydro-engineering, abrasives, newsprint, sugar, fatty acids (synthesis), shoes, optical glass, commodity standards and tire bead.

The department of research in pure chemistry had a productive year and two fellows were added to the staff. Twenty-two investigational reports have been published since the establishment of this department in 1924. Among the subjects that are receiving research attention are the chemistry of marine plants, cherry gum, gum arabic and quince-seed mucilage, and the properties of the sugar acids.

The publications by members of the institute during the calendar year 1930 included 1 book, 5 bulletins, 45 research reports and 44 other papers. Sixteen U. S. patents and 13 foreign patents were issued to fellowship incumbents. The total contributions to the literature for the nineteen years ended January 1, 1931, have been as follows: 16 books, 101 bulletins, 573 research reports, 893 other articles, and 423 U. S. patents. These publications are listed in the institute's Bibliographic Bulletin No. 2 and its four supplements.

The commencement of the construction of the institute's new home is referred to as the most important event during the year covered by the report. Early in May, 1930, it was decided that, as the present two buildings of the institution are inadequate for the immediate and future needs of its departments and industrial fellowships, a commodious modern structure would be built at the corner of Fifth and Bellefield Avenues, Pittsburgh. The excavating work, which was started on November 5, was finished in March (97,000 cubic yards of soil being removed) and the foundation is now being constructed.

The erecting of this edifice will require about two years' time, and the completed building will furnish the institute with the means for expanding greatly

its research facilities and activities in both pure and applied science. The structure, which will be of that type of classical Greek architecture known as Ionic, will be built of granite and Indiana limestone; it will be plain but massive, and will be surrounded by 62 monolithic columns. The proportions of the building will be approximately 300 feet by 275 feet, and there will be eight working floors.

SCIENTIFIC NOTES AND NEWS

DR. WERNER HEISENBERG, professor of theoretical physics at the University of Leipzig, has been awarded the Barnard Medal of Columbia University. Every five years the National Academy of Sciences recommends to the trustees of Columbia University a nominee for the Barnard Medal "for discoveries in physical or astronomical science or novel application of science to purposes beneficial to the human race." The previous recipients of the medal have been Sir Ernest Rutherford, 1909; Sir William H. Bragg, 1914; Professor Albert Einstein, 1921, and Professor Niels Bohr, 1925.

THE Institution of Chemical Engineers, London, has conferred the Osborne Reynolds Medal for 1930 on the retiring president, Mr. Arthur J. Reavell; the Moulton Gold Medal on Mr. A. T. King for his work on the treatment of suint liquors, and the silver Junior Moulton Medal on Mr. L. W. Blundell for a paper on the manufacture of hydrogen peroxide.

THE University of Manchester will confer the doctorate of laws on Dr. Arthur Harden, professor of biochemistry in the University of London, and the doctorate of science on Sir James Jeans.

DR. WILLIAM H. WELCH, professor of the history of medicine at the Johns Hopkins University, observed his eighty-first birthday on April 8.

AT the close of the annual meeting in Richmond of the Virginia section of the American Society of Bacteriologists, a dinner was tendered in honor of Dr. William H. Park, chief of the research laboratory of the New York City Health Department.

A LUNCHEON in honor of Mr. Max von Bernewitz, retiring secretary of the Pittsburgh section, American Institute of Mining and Metallurgical Engineers, was tendered to him on April 9 by the engineers of Pittsburgh. Mr. von Bernewitz has joined the staff of the Bureau of Mines at Washington.

A DINNER in honor of Dr. James H. Kimball, head of the New York office of the U. S. Weather Bureau, was held in New York City on April 9, at which he was presented with a medal and scroll. The following telegram was received by the committee in charge from President Hoover: "I will be obliged if you will express my cordial greeting to those present at the dinner in honor of Dr. James H. Kimball, and to Dr. Kimball himself my warm appreciation for his signal services in promoting the success of aviation in general and transatlantic flights in particular through his scientific skill and judgment so characteristic of the entire weather forecasting service of our country." Telegrams were also read from Dr. Hugo Eckener, Maurice Bellonte and others who have benefited by Dr. Kimball's advice. Admiral Byrd gave Dr. Kimball a silk flag that he said he had carried over the Atlantic, and also on his flights in Antarctica. Dr. Charles H. Marvin, chief of the U. S. Weather Bureau, was among the speakers.

PROFESSOR R. A. BUDINGTON and Professor C. G. Rogers, of the department of zoology of Oberlin College, have been honored at Fukien Christian University in China. A donor who wishes to remain anonymous has created at the university two scholarships which are named after the Oberlin faculty members "in appreciation and respect."

THE *Journal* of the American Medical Association reports that to observe the tenth anniversary of the discovery of insulin by Drs. Frederick G. Banting and Charles H. Best, Toronto, a course on insulin and its use, organized by the extension division of the University of Wisconsin, at the request of the State Medical Society, will be given during the week of May 18 for one day each in Madison, Milwaukee, Oshkosh, Wausau, Eau Claire and La Crosse. Dr. Leland S. McKittrick, Boston, and Dr. Russell M. Wilder, of the University of Chicago, will, with Dr. Elmer L. Sevringhaus and a dietitian of the Medical School at Madison, give lectures and demonstrations.

THE Paul Ehrlich-Stiftung has awarded Professor Levaditi, of the Pasteur Institute in Paris, the Paul Ehrlich gold medal for 1931, for his researches in the field of chemotherapy; also two money prizes to Professor Hugo Braun, head of the hygienic institute of the University of Frankfort-on-Main, and to Dr. Walter Levinthal, head assistant at the Robert-Koch-Institut in Berlin, respectively, for their researches on the metabolism of bacteria and the virus of psittacosis. The prizes were bestowed with fitting ceremonies in Frankfort-on-Main, on Ehrlich's birthday on March 4.

IT is stated in *Nature* that a new article of association of the Royal Zoological Society of New South Wales, giving the council power to confer the title

"fellow" on any member or associate member of the society who has rendered distinguished service to Australian zoology, has recently been formulated. The council has conferred this title upon R. J. Tillyard, H. J. Carter, W. W. Froggatt, T. Iredale, A. F. Basset Hull and T. C. Roughley, all of whom have contributed largely to scientific journals articles dealing with the various branches of Australian zoology.

DR. E. M. GRESS, state botanist of Pennsylvania, was elected president of the Pennsylvania Academy of Science at the close of the seventh annual meeting; Dr. S. H. Williams, of the University of Pittsburgh, was made vice-president and H. W. Thurston, State College, treasurer.

PROFESSOR DUGALD C. JACKSON, head of the department of electrical engineering at the Massachusetts Institute of Technology since 1907, was reelected chairman of the National Research Council's Division of Engineering and Industrial Research at a meeting of the division recently held in New York City. The two vice-chairmen, Dr. David S. Jacobus and Dr. Byron E. Eldred, the director, Dr. Maurice Holland, and the secretary, William Spraragen, all of New York, also were reelected.

DR. REUBEN PETERSON has resigned as professor of obstetrics and gynecology at the University of Michigan Medical School, which chair he has held since 1901. A group of men who have served as his assistants during his service on the medical faculty recently presented his portrait to the university. Dr. Peterson will continue his medical practice in Ann Arbor.

DR. ALFRED HUME, chancellor of the University of Mississippi at the time of the political dismissals by authority of Governor Bilbo, and this year professor of mathematics in Southwestern University, Memphis, Tennessee, has been named president of Branham and Hughes Military Academy, Spring Hill, Tennessee. Dr. Hume received the doctorate in science from Vanderbilt University in 1890.

MR. B. F. DANA, plant pathologist with the Texas Experiment Station since 1927, with headquarters at Temple, Texas, where he conducted research on the cotton root rot disease, has resigned to accept a position as plant pathologist with the U. S. Department of Agriculture, Office of Horticultural Crops and Diseases. Mr. Dana will work on the virus disease, known as "curly top," of vegetables. He has already started his new work with headquarters at the Oregon State College, Corvallis.

C. R. HOERNER, for some time northwest representative for the Niagara Sprayer Company, has resigned to accept a position as plant pathologist with the U. S. Department of Agriculture, Office of Drug and Related Plants, to work in cooperation with the Oregon Experiment Station on the downy mildew of hops in the northwestern states. Mr. Hoerner's headquarters will also be at the Oregon State College.

IT is announced by the Northern News Service, as quoted in *Nature*, that Dr. Hjalmar Broch, director of the marine biological station of the University of Oslo, has been appointed by the Jugoslav Government to be director of the Institute of Deep-sea Research and Fishery Investigations in the Adriatic. The Jugoslav Institute is being built at Split (Splalato), where all branches of science concerning deep-sea research will be represented, including zoology, botany and oceanography. Local methods of fishing will also be investigated, with the view of modernizing and rationalizing these.

MR. H. R. SURRIDGE has been appointed by the British government agricultural officer in Fiji, and H. E. Box entomologist in Antigua.

DR. C. M. HUFFER, assistant professor of astronomy at the University of Wisconsin, will exchange posts with Dr. C. T. Elvey, of the Yerkes Observatory, for a period of two months which started on April 7. Professor Huffer is making a study of the colors of stars and the exchange will give him opportunity to continue his work with the aid of the 40-inch telescope of the Yerkes Observatory.

DR. WILLIAM ALLEN PUSEY, past president of the American Medical Association, left for Mexico City on March 21, to discuss plans for Mexico's participation in the Century of Progress Exposition, to be held in Chicago in 1933.

DR. MALCOLM H. SOULE, of the Medical School of the University of Michigan, has returned to Ann Arbor from the School of Tropical Medicine in San Juan, Porto Rico, where he has been a visiting professor and special investigator for the past three months.

DR. C. D. ELLIS, of the Cavendish Laboratory, University of Cambridge, has been appointed a member of the staff in physics for the 1931 summer session at Cornell University. Dr. Ellis, who is an authority on β- and γ-ray radiations, will give courses covering the general field of radioactivity with particular emphasis upon nuclear structure and will devote a portion of his time in assisting a small group of investigators to become acquainted with the technique of radioactive work.

PROFESSOR EDMUND LANDAU, of the Mathematical Institute of the University of Göttingen, is expected to arrive in New York on April 24, on his way to California, where he will lecture during the summer at Stanford University. He will remain in New York for several days after his arrival and has accepted

an invitation to lecture at Columbia University on April 27 on "Binary Linear Forms." Professor Landau is an authority on the analytic theory of numbers and on the theory of functions.

THE following will be visiting members of the faculty of chemistry of the Ohio State University during the summer session of 1931: Professor Harry B. Weiser, of the Rice Institute, in colloid chemistry; Professor R. C. Fuson, department of chemistry, University of Illinois, in organic chemistry, and Professor Guy Mellon, of Purdue University, in inorganic chemistry and bibliography.

AT the University of Pittsburgh, Dr. A. Lande, recently appointed professor of theoretical physics at the Ohio State University, delivered a lecture on March 12 on "The Quantum Theory of Abnormal Mean Free Paths," under the auspices of the department of physics and the Physical Society of Pittsburgh, and Dr. G. W. Stewart, head of the department of physics of the University of Iowa, delivered a lecture on "The Nature of the Liquid State" on March 26.

DR. CHRISTIAN A. RUCKMICK, professor of psychology at the University of Iowa, will give a series of lectures on the "Facial Expression of Emotion" and the "Galvanic Technique in the Investigation of the Affective Processes" during April on a tour to the Pacific Coast. The institutions visited include the University of Nebraska, the University of Denver, the University of Utah, the University of Southern California, the University of California, College of the Pacific, Stanford University, the University of Oregon, the State Normal College at Bellingham, Washington, Whitman College and the University of Montana. On March 20, Dr. Ruckmick lectured at Northwestern University.

PROFESSOR S. P. FERGUSSON, of the United States Weather Bureau and aerologist of the University of Michigan Greenland Expeditions, will give a semi-popular course of lectures at the University of Michigan under the general topic, "Data and Problems of Aerology." These lectures are given under the joint auspices of the College of Engineering and the department of geology and will begin April 20 to continue through two weeks.

DR. COLIN G. FINK, professor of electrochemistry at Columbia University, recently lectured before the American Chemical Society Sections of North Carolina, Alabama and Syracuse, N. Y., the topics chosen being the "Electrochemical Restoration of Ancient Bronzes," "Corrosion" and "Recent Advances in Applied Electrochemistry." In May he will address the Lehigh Valley Section on "Alloy Anodes and Alloy Cathodes."

DR. HARLAN T. STETSON, director of the Perkins Observatory and professor of astronomy at the Ohio Wesleyan University, will give a lecture on April 24 on "Astronomy and Electricity" before a joint meeting of the New York Section of the Institute of Electrical Engineers and the New York Electrical Society. The lecture will be given in the Engineering Auditorium at 8 p. m.

PROFESSOR A. G. SHENSTONE, of Princeton University, spoke at the Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania, on March 13, on "Recent Researches in Spectra."

DR. E. W. NELSON, for eleven years head of the United States Bureau of Biological Survey, recently visited the Scripps Institution of Oceanography of the University of California, where he gave an informal talk to members of the staff on his experiences in collecting specimens from this country and Mexico.

DR. KARL J. FREUDENBERG, Carl Schurz memorial professor of the University of Wisconsin, is delivering a series of eighteen lectures at universities and chemical associations of the United States and Canada. Professor Freudenberg will lecture on "Optical Activity and Configuration," "Insulin," "Some Aspects on the Constitution of Cellulose and Other Carbohydrates," "Lignin," "Vegetable Tannins" and "Recent Chemical Evidence on the Constitution of Cellulose."

THE Second International Congress for Light Therapy will be held in Copenhagen from August 15 to 18, 1932, under the presidency of Dr. Axel L. Reyn. The purpose is to study all questions relating to biological and biophysical researches in connection with light and light treatment. Further information may be had from the secretary-general, Dr. A. Kissmeyer, Finsens Lysinstitut, Copenhagen.

ESTABLISHMENT of a fellowship in the Department of Engineering Research for the study of problems in the distillation of petroleum carbohydrates was announced by the regents of the University of Michigan at their last meeting. The grant will be known as the M. W. Kellogg Company Fellowship in Chemical Engineering, and will consist of $1,000 a year for two years. Mr. M. J. Kellogg, of Jersey City, N. J., made provision for the fellowship.

BY the will of the late Professor John Henry Comstock, Cornell University receives the bulk of his estate. The will directs the establishment of the Grove Karl Gilbert loan fund for self-supporting students. The Comstock Publishing Company, which issued books on nature study, also goes to the university. The Ithaca Memorial Hospital and the Unitarian Church receive $1,000 each. The will was made jointly with that of Mrs. Anna Botsford Comstock, who died in August, 1930.

UNDER the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father, the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade (Marine Department). The objects of the trust are "The Advancement of the Science of Navigation and the Scientific and Educational Interests of the British Mercantile Marine." The council now offers the following prizes: A prize of £100 to any person who may bring to their notice a valuable improvement in the science or practice of navigation proposed or invented by himself in the years 1930 and 1931. A prize of £100 for an essay on "The stability of ships, with special reference to the particulars which should be supplied by shipbuilders, and also the value of any mechanical devices for ascertaining the M. G., with which you are acquainted." Further information may be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, London W. C. 2.

FOR the twenty-third consecutive season the University of Michigan will maintain its summer station for instruction and research in biology from June 29 to August 22, on the shores of Douglas Lake, Cheboygan County. Because of its natural surroundings, the Douglas Lake site offers unique opportunities for pursuing a variety of problems in biology. To the north of the camp is a region of evergreen coniferous forests, while to the south are hardwood forests, making the station the best situated in this respect of any in the country. Lowlands near the lake furnish a variety of plants, including orchids and insect catching types, while Cecil Bay and Big Stone Bay on Lake Michigan are not too distant for study of forests free from fire for fifty years. Bird and animal study is facilitated by the wide variety of natural conditions. A beaver colony with three dams is near by, and 150 species of birds are found in the region in summer. Invertebrate fauna, mollusks, both land and aquatic, crustacea, insects and examples of animal parasites are numerous and well suited to study.

DISCUSSION

A METHOD FOR EXPLANTING THE KIDNEY

ACCURATE determinations of the physiological activities of the kidney require that successive samples of blood be drawn from the renal vein in healthy, unnarcotized animals. A suitable technique for attaining this end has long been desired but has been difficult to evolve. Certain surgical procedures have been carried out in animals under ether anesthesia in an attempt to solve the problem.

Both rabbits and dogs have been employed as experimental animals. In preliminary trials, the left kidney was brought out through a small lumbar incision and the skin and muscle layers were lightly closed around the pedicle. Protection from trauma and drying was afforded by the use of a simple but effective dressing, and after a considerable period, epithelium grew in from the edges of the skin, eventually covering the entire organ. Following removal of the right kidney, animals so treated have remained in perfect health for more than a year. It was found, however, that an excess of granulation tissue formed about the base and prevented easy access to the vessels. This procedure was therefore abandoned, and an effective operative technique substituted.

Dogs were found to be more suitable for these tests. In these animals it was possible to bring out the kidney through a simple, muscle-splitting, lumbar, flank incision and to close the muscle layers loosely around the pedicle. The organ was then tipped posteriorly to render the renal vein as prominent as possible, and a flap of skin was brought down over the organ from the dorsal side and so sutured as to make the position of the kidney a permanent one. Then a strip of skin was cut and sutured down to the subcutaneous tissue on either side of the renal vein. leaving the vein covered by and enclosed in a gutter of skin which was semi-circular in cross-section.

The wounds healed by first intention, and within ten days the right kidney could be removed safely. With the removal of the right kidney, a carotid artery was usually explanted in a tube of skin in accordance with the method described by Cohn and Levy. This was done to facilitate arterial puncture and to obtain constant records of blood pressure.

The technique described herewith has been carried out on forty-five animals, the first of which are now six months post-operative, in excellent health, and without evidence of renal insufficiency as evidenced by alterations in blood chemistry.

By explanting kidneys in the manner outlined above, it has been possible to determine renal circulation, urea excretion and utilization of oxygen by the kidney under a variety of conditions.

C. P. RHOADS

THE HOSPITAL OF THE ROCKEFELLER
INSTITUTE FOR MEDICAL RESEARCH,
NEW YORK CITY, N. Y.

CENTRAL BODIES IN THE SPERM-FORMING DIVISIONS OF ASCARIS

THE early investigations of O. Hertwig, Brauer, Boveri and others have long been regarded as estab-

lishing the identity of the centrioles seen in the sperm-forming divisions with the similar ones found in other types of mitosis, including the maturation-division of the egg. This comparison has recently been challenged with the contention that in the sperm-forming divisions the centriole is only secondarily associated with the astral centers, and that it is primarily a blepharoplast for the production of the axial filament of the sperm-tail. A crucial test for this interpretation is offered by *Ascaris megalocephala,* where the mature sperm shows neither tail nor axial filament. It was with this point in mind that the late Professor Robert H. Bowen suggested a reinvestigation of the facts in that animal.

My preparations of the sperm-forming divisions in *Ascaris megalocephala* make it perfectly plain that in all essentials the behavior of the centrioles conforms exactly to the classical scheme. There can be no doubt of the fact, uniformly seen in large numbers of cells, that in the first metaphase the centrioles divide at a time when neither the surrounding centrosome nor the aster show any indication of division. In the early anaphase the centrosome becomes ellipsoidal and divides, each daughter centrosome containing a centriole. It is toward the end of the telophase stage that these daughter centrosomes, each with its centriole, begin their movement to opposite sides of the cell, never losing their identity from this stage to the prophase of the next division.

These facts can easily be demonstrated and with perfect clearness. Since in this animal the sperm has no flagellum or axial filament there is no ground for considering the centrioles as blepharoplasts or as differing in any material way from those seen in the mitosis of other kinds of cells.

These results, confirming in all essentials those of the early cytologists, are to be reported in detail hereafter.

HARWELL P. STURDIVANT

COLUMBIA UNIVERSITY

MORE ABOUT SHIPWORMS

ON my return from the West Indies my attention was called to Dr. W. T. Calman's article, "The Taxonomic Outlook in Zoology," being the address of the president of Section D—Zoology, of the British Association for the Advancement of Science, published in SCIENCE, September 19, 1930. On page 281, Dr. Calman uses the sentence:

> Dr. Bartsch, of Washington, in his "Monograph of the American Shipworms" (1922), simplified his task by the assumption that any species found on the coasts of the American continent must, of necessity, be different from any found elsewhere, and he was thus able to write "n. sp." after twenty-two out of the twenty-nine specific names. It was soon shown, however, by other American zoologists that this assumption was without foundation, and that the most destructive species on both the Atlantic and Pacific coasts of North America was the European *Teredo navalis.*

Personally this note has called for no resentment on my part, but only provoked a smile; yet some of my best friends insist that it requires a "retort courteous," lest it be deemed that silence on my part be consent.

European shipworms, unlike men, are apparently as clannish as American shipworms. American shipworms have been carried by the Gulf Stream from the West Indies to European shores since the Gulf Stream came into existence, or, probably still better, since trees grew and were set adrift in the West Indies by various agencies. These trees have always fallen a prey to shipworm attacks, and American shipworms in such floating timbers have thus paid visits to European shores since time immemorial.

Jeffreys, who has done more work upon European shipworms than any other man, pointed out long ago that in spite of the constant immigrations from American waters none of these sea waifs had succeeded in establishing themselves in European waters. By a study of the extensive Jeffreys collection, which rests in the United States National Museum, I am able to confirm his conclusions. The environmental factors of the two regions are evidently sufficiently delimiting to prevent such colonization.

Why some American authors, and my critic, persist in claiming that European shipworms are less choice in selecting a habitat than the American forms has always been a puzzle to me, and seems explainable only on three grounds: (1) European man has found America good; why shouldn't shipworms? (2) Because we love to cling to ancient concepts and are loath to change them. In the days gone by, due to little comparative material much sloppy work was done in determining shipworms and many names belonging to European species were hastily and wrongly applied to American forms. (3) The game of playing politics in science has recently crept in, it being the belief of some naturalist that if we had only one shipworm, *Teredo navalis,* in all the waters of the world, we could get a better or easier hearing for the forming of an international attack upon this animal. Personally, I do not see that it makes any difference whether there is one species or a thousand species of shipworms. Shipworms, except where cultivated for food, as in Siam, are like the Indians of old, all bad, and undesirable.

I find upon careful study based upon a huge amount of material that shipworms are well-behaved mollusks following the laws of distribution that dominate the other bivalves, and I see no reason or justifi-

cation to change any of the views expressed in Bulletin 122 of the United States National Museum. The mass of material that has come to me since that paper was published is all confirmatory of the views expressed there. I fear, therefore, that Dr. Calman's arrow will prove a boomerang that is bound to return to the sender.

Incidentally I wish to refer the reader to two previous notes of mine published in SCIENCE, bearing upon this same subject: One, "The Status of Teredo beachi and Teredo navalis," a paper which appeared in SCIENCE for June 15, 1923, page 692, and evidently overlooked by Dr. Calman, in which I called attention to the fact that these two shipworms were not only not synonymous but did not even belong to the same sections of the subgenus *Teredo.* I gave in that paper the characters that separate them, so they do not need to be repeated here.

Again, "Stenomorph, a New Term in Taxonomy," published in SCIENCE, Volume 57, March 16, 1923, on page 330.

Quoting again from Dr. Calman:

> Nevertheless, the taxonomy of the group remains in a *state of the utmost confusion.* There is no agreement as to the limits even of the genera, and the inconstancy of the characters that have been used for the definition of species is plain to any one who studies a large collection.

This cry is not an unusual one. We hear it expressed by specialists in all branches of natural history. Usually it means that the individual thus afflicted has for want of time or inclination failed to go to the bottom of things in his study, and expresses his weariness by saying that things are in "utmost confusion." I have yet to find a species that can not readily be placed in the proper subgeneric group in the classification that I submitted in Bulletin 122, or my subsequent paper, "The Shipworms of the Philippine Islands," Bulletin 100, Volume 2, Part 5, U. S. National Museum, 1927, excepting such cases where new groups that were unknown at the time of the publication of these papers are involved. While I do not claim infallibility, I nevertheless believe that this classification is based upon a sound foundation—shell characters.

The shell, in spite of what some soft anatomists would preach, is the soundest single element that one can use in the classification of mollusca. It is comparable, as far as its value for classificatory purposes is concerned, to the skeleton of mammals, birds, reptiles, batrachians and fishes, that is, the vertebrates. I believe that no one will challenge the use of the skeleton of vertebrates for that purpose, and in mollusks this use is even less assailable, for in the molluscan skeleton, unlike that of the vertebrate, we have the story of the entire ontogeny of the animal engraved upon its skeleton. We are therefore able to see, on a perfect specimen of a shell, the sculptural characters that were impressed upon the parts that develop while the animal was still in the egg or the uterus of the parent, as well as the subsequent additions of characters acquired during the various phases intervening between the egg and senescence. In no other group that I am acquainted with—vertebrate or invertebrate—do we find such a perfect complete story of the life history engraved upon any part of the anatomy of an animal. In the other groups each life stage has its features which are modified or eliminated by subsequent development, while in the molluscan shell we have simply a series of additions with perfect preservation of the preceding stage or stages. I maintain, therefore, that the shell is of prime importance in the classification of mollusca. I may here also add that the geological record is based upon this element.

Likewise do I wish to call attention to another very interesting fact brought out by my Cerion breeding experiments, where we found that crossing *Cerion viaregis* with *Cerion incanum* produced an endless number of mutations in the F^2 generation. The shells of these animals, while they present innumerable changes in sculpture and coloration, would nevertheless be recognized as Cerions by any amateur. Not so the anatomy! The dissection of one hundred of these hybrids has brought to light such changes in the organization of the soft parts that had we soft parts only and no shells to check against, different family or even higher rank might have to be assigned to some of these mutations. The same story was expressed by the dissection of one hundred individuals representing a native wild cross of *Cerion peracuta* and *Cerion tridentata.* These facts will be fully presented in a paper which is almost completed. It is sufficient to simply state here that the facts adduced from this Cerion breeding point strongly to the conclusion that the soft anatomy of mollusks is less stable than the shell. This, combined with the fact that the soft anatomy of animals presents at any one time only the particular age or functional stage of that animal, while the shell has engraved upon it all its history up to the time of its demise. A study of the cytology, embryology metamorphosis, as well as that of the adult characters of a shipworm should, and I hope will, give confirmatory evidence for what I claim as facts presented by the shell.

The classification offered in Bulletin 122 was the first attempt in trying to bring up to date the classification of a group of mollusks that had for some time been seriously neglected. New groups since discovered will require its expansion. Here, as in every

other group we must look for further modifications, as our knowledge of the subject increases, but I am convinced that the basis upon which it is founded is sound.

Paul Bartsch,
Curator of Mollusks and Cenozoic Invertebrates
U. S. National Museum

THE RUSSIAN ACADEMY OF SCIENCES

Homo hominis lupus est.—Old proverb.

The President of the Russian Academy of Sciences, Dr. A. P. Karpinsky, the distinguished geologist, is leaving his post at the academy. This decision is the outcome of his unsuccessful protests against the recent forced decision of the academy to deprive of its membership four academicians, including such historians as S. F. Platonov and E. V. Tarle, whose scientific views have been pronounced by the authorities to be incompatible with their presence in the academy of a communistic state. It is noteworthy that at the same meeting of the academy several foreign scientific workers were elected as foreign members. It appears clear, in the circumstances, that the acceptance of membership of the Academy of U. S. S. R. must involve silent agreement with the basic principle underlying the attitude of the Soviet authorities toward science.—*Nature, March 7, 1931, p. 346.*

I visited Russia, Siberia and Russian Turkestan (Usbekistan) in 1927, and gave, in *Nature* of November 19 of that year, a brief account of the biological work as I observed it in the U. S. S. R. I was greatly impressed by the volume and variety of the work done, and the fact that all the scientific men I met were industriously cooperating to increase knowledge and education throughout the country. Even at that time it was declared that the professors holding over from pre-revolutionary times would be replaced by "Red" professors as soon as practicable; but although this appeared ominous, I hoped that the actual results would not be definitely unfavorable to science. My more or less optimistic view resulted from acquaintance with a number of young men and women in course of training in the universities, and presumably destined to do the research and academic teaching of the not distant future. They appeared to be on the whole sensible, enthusiastic young people, whose contacts had been broad enough to free them from excessive political dogmatism. I hoped that they would continue to be governed by the true spirit of science, and saw in them the best hope for the Russia of to-morrow.

The Academy of Sciences at Leningrad, combining the functions of the Royal Society and the British Museum, has been the great intellectual center of the country. In its museum are preserved innumerable scientific treasures, excellently arranged. During the early days of the revolution it took all the efforts of Dr. Karpinsky and his daughter to prevent irreparable damage. As it was, a few bullets came through the windows, but no serious injury was done. When I was there, the academy appeared full of energetic and capable workers, who were glad to exhibit some of the latest results of their investigations. Dr. Karpinsky was presiding over a committee to consider the geological and physical aspects of the proposed railway between Usbekistan and Siberia (Turksib railway), which has since been successfully completed. I did not hear anything to suggest that the scientific men were not doing their very best to aid the country and develop its culture. The venerable Karpinsky, over eighty years of age, was as active as a young man.

Yet, in the midst of all this happy and fruitful activity, there was a note of alarm. It was as though one lived in a country of earthquakes, never knowing what the next hour might bring forth. Every one knew that it was possible to be arrested, usually in the small hours of the morning, and carried off to some place not designated. The brother of one of my best friends had disappeared in this fashion, and although the family found out what had become of him, they could only guess at the cause of his arrest. I believe he has now regained his liberty. I had in my pocket a little note-book, crammed with scientific information, and including addresses of people I had met and a sketch-map of the streets of Irkutsk. An official (not of the academy) who happened to see it was greatly alarmed. What would they do if they found that? Yet it contained nothing whatever of a political nature, and as a matter of fact no one asked to see what was in my pockets. At Tashkent we were asked to meet a lady who had been born in California, but had married a Russian and lived for many years in Turkestan. My wife being an old Californian, they wished to talk over old times. But when we sat down to the meal where this lady should have appeared, a note was brought, stating that she could not come, for reasons she would explain later. When we returned through Russia, we learned that we should cross the Volga about midnight. So my wife and I remained awake, and when we came to the great river got up and looked out of the window. We were about a third of the way across when a soldier with a gun appeared, and ordered us back to bed. This was done as a matter of routine; he did not know who we were.

I cite these various occurrences as typical of the existing state of mind. The government is afraid of the people; the people are afraid of the government. I spoke of this to an intelligent Russian. Yes, he

said, of course, but it has always been so in Russia. That is something to remember. The essential liberty and sense of security we enjoy in this country has never existed in Russia. Our race only attained these blessings through a long struggle lasting many centuries.

Scientific men, as such, have no cause to favor the capitalistic system as against the socialistic. On the contrary, the brotherhood of science is a great universal democracy in which free cooperation is essential for progress. The logic of events is forcing us more and more in the direction of socialistic activities, making us more and more responsible to one another. The socialization of agriculture with large scale production and the use of modern machinery is undoubtedly the only adequate way to feed Russia's millions. For my own part I can certainly say that I have a high regard for the Russian people, and fervently hope that they may win through to a condition of prosperity and happiness.

It seems to me that the government is defeating its own ends. Even those in its inner councils are playing a dangerous game, and may be thrown out, like Trotsky. It is very difficult in the nature of the case for the small group of political dictators to understand what people think of their activities. They may be entirely well-intentioned, but they too easily conceive themselves to be endowed with all wisdom. They follow a dogma which was developed long ago, under different conditions. There is no dictatorship of the proletariat, but only of a few members of that type over the millions of their fellows. Fortunately, there is a limiting factor in the lack of ability of this small council to keep its fingers on all that is going on in such a vast area. In many directions, favorable influences, developing locally, may be observed. But as long as the whole country is in effect subject to army discipline, is visualized by the leaders as at war, the growth of normal and peaceful socialism is to that degree hindered. Science can only prosper where there is freedom to investigate and state the results. It appears to be the duty of scientific men throughout the world to oppose the policy of making the Russian Academy, or the schools of Tennessee, subservient to a dogma. In so doing we do not thereby express any hostility to the dogmatists, or necessarily disagreement with their opinions, but simply the view that it is contrary to the spirit of science to be governed by *a priori* decisions, imposed in the interests of non-scientific groups.

Can we ever convince those whose policy we thus necessarily oppose? It may seem a hopeless task, yet I do not believe that expressions of opinion, prompted by no ill-will toward the country, can be wholly without influence. Times will change, as they have before, and what was hardly hoped for will perhaps be attained. In any case, we can not otherwise than do our best.

T. D. A. Cockerell

University of Colorado

A CONFERENCE ON HEREDITY AS APPLIED TO MAN

The following memorandum presented to the White House Conference on Child Health and Welfare and referred by the chairman, Dr. Ray Lyman Wilbur, to the continuation committee of that body, is offered for publication in Science in the hope that biologists and others will use their influence in favor of a future conference on heredity in relation to man as suggested by the Minnesota group.

Representing a group of biologists of the University of Minnesota, I wish to record the conviction that too little attention has been paid to heredity in this conference. One has but to envisage a conference on farm stock, as contrasted with human stock, to see how great a part heredity would play in the discussions and recommendations of such a body. We believe that the knowledge of heredity already existing offers great possibilities for race improvement—quite as important, in the opinion of many authorities, as the environmental factors to which so much attention has been given. We are moved by the contrast between the very large expenditures of public funds, foundation endowments and private gifts, the enormous amount of social effort of all kinds, exerted on the environmental side, and the comparative neglect of the practical aspects of heredity as applied to man. We feel that heredity deserves far more consideration from philanthropic persons and societies, socially minded individuals, constructive statesmen, than it has ever received.

We are aware of the unsatisfactory present situation of ignorance, of prejudice, of unscientific propaganda. We attribute this situation largely to absence of an authoritative, united declaration on the part of experts in this field. We suggest that there be held, either under governmental or private auspices, a conference in which all phases of this fundamentally important subject may be investigated and discussed as fully and frankly as the environmental side has been at this conference. From such a conference we should hope for an authoritative program leading, as the generations progress, to the realization of what we believe should be the first cardinal declaration of a Magna Charta of Childhood: Every child is entitled to be well born.

In presenting this memorandum it is not our intention to criticize or detract from the work of this conference. We are concerned only with the effort to secure a future authoritative conference devoted to heredity as applied to man.

E. P. Lyon,
Dean

University of Minnesota,
The Medical School

SCIENTIFIC BOOKS

A Textbook of Plant Physiology. By N. A. MAXIMOV, translated from the Russian. Edited by A. E. Murneek and R. B. Harvey. McGraw-Hill Book Company, New York and London, 1930.

THREE Russians and their translators have given us treatises on plant physiology in English within the last twenty years. Of these the one most readable and, one would say, the only one likely to be read by the so-called general public, has drawn little attention. Entitled "The Life of the Plant," by the eminent Timiriazeff, its text fits its title: it is an admirable treatise, in a style now old-fashioned. The second has experienced repeated revisions and additions. "Plant Physiology," by Vladimir Palladin, edited by Livingston, represents, like its predecessor, the voluntary effort of author and Anglicizer. It exhibits the chemicalizing of the science. The third, Maximov's "Textbook of Plant Physiology," edited by Murneek and Harvey, carries the chemicalizing and physical chemicalizing still further, and was produced under the changed conditions in Russia to-day. It is one of the many works which we must expect to see produced in the Russian scientific laboratories, works characterized by the brilliancy and unevenness of the Russian. I will not attempt a disquisition on the character, quality, volume and value of the products of social and economic conditions in which one is not free to follow one's inclination, but in which one is so protected against "loss of the job" that one may be as "crazy" as one pleases. The tangential brilliancy of certain Russian scientific workers at the present moment is, I believe, to be explained in part by two convictions: that they are sure, for themselves and their families, of subsistence and shelter, of a sort; and that, however careful they need be about political matters, they are perfectly and irresponsibly free about other intellectual interests. They may indulge themselves in mitogenetic rays or any other inventions, as they choose! Furthermore, if writing is more to their taste than operating microscopes, microtomes and physiological apparatus, it seems to be a perfectly possible alternative. This may, therefore, account for the stream of Russian "contributions to science," of which we are, I believe, only at the beginning, and which is likely to continue as long as the present Russian economic system.

We have in Maximov's text-book an attempted summary of the essentials of plant physiology to-day. In the case of a translation especial care is called for in discussing a book; but in this instance certain details can readily be attributed to the author and others as readily to the editors. While the author's preface to the English translation states that "the translation of the book" was done at his request by three women in Leningrad and a fellow countryman in this country, the result was "edited" by two Americans. The result is an *American* not an *English* translation. The language is not what the merits of the book justify. Colloquialisms ("ironed out") and awkwardnesses are too frequent. The grammatical error of disagreement of subject and predicate in number is difficult to understand, though surprisingly common in certain areas of this country. To cite two examples: On page 67, "Some geologists, as for instance Vernadsky, attribute*s* to the accumulating power," etc., the superfluous *s* being italicized; and on page 214, "However, very soon there *is* revealed in such cells many irregularities and digressions," etc., where *are* should be used instead. These are not errors in proof-reading, such as the wrong number of a figure cited at the top of page 111; they are errors of speech, localism, perhaps a dialect, but none the less regrettable.

The author is presumably responsible for the illustrations, almost without exception borrowed, never in any sense original, even where greenhouses are photographed for the purposes of this volume. Definition and conception of what constitutes a text-book are individual matters, but where author and editors claim that "The text brings up to date the results of physiological research both in Russia and in the United States," one may reply to this challenge by citing that what in the United States is now generally called photosynthesis is in the book still named carbon assimilation; that there is no mention of carbonates and bicarbonates as sources of carbon, the fifty-year-old doctrine of Liebig being the only one mentioned; that the definition of osmotic pressure on page 109 is a definition rather of turgor pressure than of its cause; that the well-known researches of Sponsler are not mentioned, although they throw light on the subject discussed on page 202; that, like its predecessors, this book pays almost no attention to the second and presumably no less important product of photosynthesis, namely, the oxygen, although one should realize that, unless it is released through a wound, its escape from the tissues which liberate it is inconspicuous, slow and incomplete; that Sir James Dewar is the name of the inventor of the most effective insulators so far produced for laboratory or commercial use and not Dewars. It is unfortunate that

the eminent Hollander Went, and his remarkable son, should have their name Germanized to Wendt; and in this connection one may remark that, while the author is probably right, his complete devotion at this time to the idea of hormones as regulatory influences would be regarded by conservatives as premature, and by most persons as too partisan for the author of a "textbook."

So much for some faults. The excellences of the book are no less marked. The treatment of those physiological processes and relations in which water is so largely involved, as in photosynthesis, absorption and transpiration, is that of the master dealing with facts to which he has made his own contributions. Other parts of the book are more compilatory and involve again the individual sense of perspective. The book is so valuable, so usable, that its faults are the more regrettable.

G. J. PEIRCE

STANFORD UNIVERSITY

Introduction à la Biologie Expérimentale. Les êtres organisés. Activités, instincts, structures. By PAUL VIGNON. Preface by M. E. L. Bouvier. Encyclopédie Biologique VIII. Paul Lechevalier, Paris, 1930. Octavo. Pp. viii + 731. 890 figs. 23 pls., 3 in colors. Price 210 frs.

THOSE who have had the pleasure of attending the brilliant lectures of Professor Paul Vignon at the Catholic Institute in Paris will not be surprised at their culmination in a book that is both unique and fascinating. The charm of this versatile guide is irresistible as he conducts us in this book through the fields of animal behavior, protozoology, mimicry and protective resemblance, and the evolution of types by mutation and orthogenesis.

Plentiful, excellent illustrations accompany the story, many of which, especially those on protective coloration and form, including three colored plates, are original. Vignon is a skilful artist.

He is also a thorough-going Aristotelian philosopher. An organism, an organ, any natural phenomenon, is to him an "idea," the expression of ultraspatial, supernatural control. "The living being is enclosed within a wall behind which the drama of life is enacted." By peering through crevices in this impenetrable fortress, the biologist seeks an inkling into that which is taking place. A plan is in it all; ideas are everywhere, even though some of them are whimsical, such as the monstrously overgrown protuberances of the prothorax in certain leaf-hoppers, which are grotesque and, except as disguises, useless. Yet, in spite of such caprices of nature, nothing is fortuitous nor the outcome of blind mechanism.

Although this philosophy runs like the theme of a symphony through the book, emerging here and there in summaries, the author presents an array of facts from his own observations and the works of others which will be of interest to the psychologist, protozoologist, entomologist and biologist generally.

In the chapters on animal behavior, upholders of the Gestalt-theory and of emergent evolution will find much that is in harmony with their way of thinking; the observations and experiments of Koehler and Jennings, for example, are by no means neglected; but one looks in vain for the name of Jacques Loeb or mention of his theory of tropisms. Naturally the more dramatic incidents in the lives of insects and protozoa are stressed, and they are narrated vividly, but with the careful regard to fact characteristic of a well-trained zoologist.

The mysterious organ-forming "idea" appears in the numerous forms of great beauty in the Radiolaria and in the choice and arrangement of materials for the shells of Foraminifera. No hope is offered that biophysics and biochemistry may eventually explain any of these phenomena, but evolution by mutation is regarded as the way by which organisms proceed toward their goal of utility and beauty. Natural selection, however, is a vain formula; to Vignon orthogenesis, teleological control, is paramount.

The chapter on mimicry, which is defined broadly to include protective resemblances, amply describes the disguises of gastropods, crabs, spiders, and many insects, and is especially valuable because it treats of the flower- and leaf-like Orthoptera to which the author has devoted much research. These include African and Indian mantids which lurk among flowers and turn toward the light and their prey the brilliant colors of their ventral surfaces. Flat expansions of prothorax and coxal segments, colored like flowers, attract small insects into the grasp of the mantid's fore legs.

Even more remarkable are the leaf-like grasshoppers of tropical America, *Pterochroza* and its allies, many of which have been described for the first time by Vignon.[1] The fore wings, even of those which are green, mimic old leaves, with highly variable excised margins and blotches like fungus colonies. These spots are of various sizes in some cases, apparently representing different stages of development of the make-believe fungus.

Other South American grasshoppers of the phaneropterid genus *Pycnopalpa* have great blotches on their green wing-covers, suggesting the ravages of the elm-leaf beetle.

That physiological, physiochemical processes play

[1] P. Vignon, "Recherches sur les sauterelles-feuilles de l'Amérique tropicale," Archives du Muséum, 6, V, pp. 57–214, 1931. 58 figures. 1 pl. en couleurs, 12 pls. en simili-gravure, 12 pls. en phototypie.

a part in wing development and coloration appears not to occur to Vignon, such matters obviously being enveloped in an impenetrable cloud of mystery. He calls attention, however, to the important fact that, in many insects, mimetic structure and the instinct for making use of it develop inseparably. This proves the utility of the mimicry, but can the selectionist show that its possessors have thereby an advantage in the rate of reproduction? This question, likewise, does not interest Vignon, who prefers to think that mimicry "serves to show that Life knows how to introduce something personal and new into nature."

In the final chapter, examples are given of mutations and "orthogenetic series" offered as proofs of evolution. Here are described an example of mutation in *Drosophila,* changes which the wing muscles of Dragon-flies have undergone since the Carboniferous, the strange metamorphosis of the parasitic cirriped *Sacculina,* the change of the reptile's jaw into the bird's toothless beak, of the reptile's scale into the feather, eventually into the gorgeous plume of the bird of Paradise, and finally the evolution of the pine cone into the various types of inflorescence of the higher plants.

Whether looking at the world through mechanistic, organistic, or vitalistic glasses, one can not but admire the vigorous, vivid style, the adequate descriptions and excellent figures of this unique book. Although the experimentalist will find its method deductive and descriptive, rather than that which in America we call experimental, he will find here plenty of problems which seem to require experimental treatment, or he may prefer to turn his imagination into other channels and think of them awhile, as would the poet or artist, simply as ideas.

John H. Gerould

Dartmouth College

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN AUTOMATIC BALANCE

During the course of studies of the relation of soil moisture to plant growth extending over more than a decade it has been necessary to weigh many thousands of soil samples. We have designed and constructed, with the tools usually available in most laboratories, a simple and inexpensive balance which we believe has unique features and which we have found to increase very materially the speed with which weighing may be made.

The balance, which operates on the displacement principle, is shown in Fig. 1. This balance, which has a capacity of 3 kilograms with a sensitivity of 20 milligrams at full load, is of German make and is on sale by most dealers in laboratory equipment in this country. We are also using our device on an analytical balance. Probably many standard makes of beam balances would serve as well as the one illustrated. It will be apparent from the following description that there are, however, several features which are desirable in the balance to be used as a base for our device. The balance is arranged to weigh an article in the left-hand pan by placing weights in the right-hand pan until the difference in weight is 10 grams or less, which is recorded on the scale *a*. The inequality in weights on the two pans is compensated for by the depression of the plunger *b* in the displacement cup *c*, the plunger being depressed until a quantity of liquid is displaced which is exactly equal in weight to the difference in the loads on the weighing pans. A circular disc *d* of slightly less diameter than that of the displacement cup is attached to the plunger *b*. The disc *d* is to dampen the movement of the plunger, and the plunger assembly with the cup and liquid acts as a dashpot.

The plunger assembly is hung from a yoke *e* which

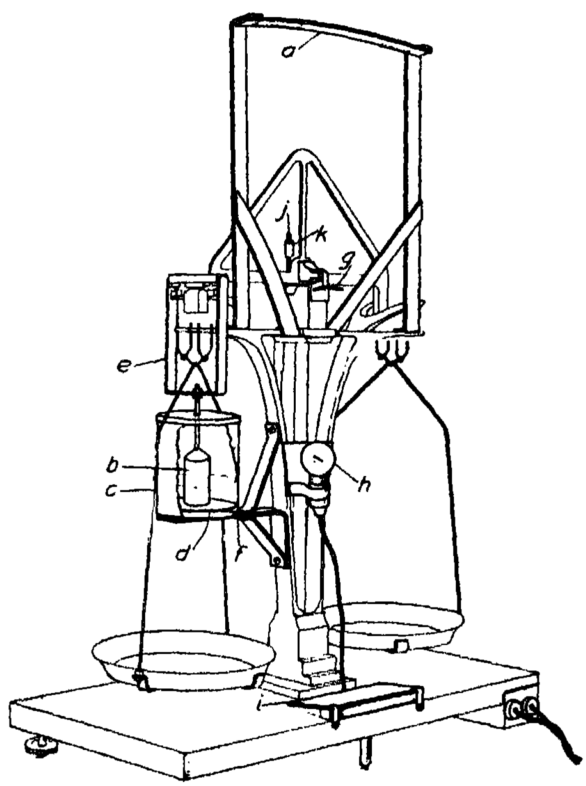


Fig. 1. View from the rear of balance with displacement cup cut away to show plunger assembly. The attachments placed on the stock balance are shown by heavy lines.

is attached to the cross-bar carrying the agate plane for the stirrup and pan hanger. The yoke is pivoted in the cross-bar at points in line with the face of the agate plane by two cylindrical pins so that it can swing freely and its motion be independent of that of the weighing pan. One of the desirable features of the balance is that the stirrup be returned to a fixed position when the knife edges are removed from the agate planes. The beam of the balance must be supported so that it is restrained from horizontal movement and must return to its former position when lowered after being raised. The clearance between the periphery of the disc *d* and the sides of the cup *c* is small, and any considerable movement out of line of the plunger will cause it to stick. The displacement cup *c* is attached to its support *f* by means of lugs which pass through slotted holes so that its position may be changed slightly to center the cup in relation to the plunger assembly.

A spherical concave mirror *g* is attached to the back of the beam of the balance so that its reflecting surface is tangent to a line projected from the central knife-edge. A 3-volt single filament lamp *h* is attached to the back of the balance on an adjustable plate. A small transformer reduces the line voltage from 110 to 3 volts. The lamp is adjusted until the image of the filament is focused on the scale *a* when the beam of the balance is raised. The image of the lamp filament is reflected from the concave mirror *g* down to the plane mirror *i* and thence up to the scale *a* which is attached to a metal piece shaped to the proper arc. The movement of the beam of the balance, then, is greatly amplified. In effect we have a weightless pointer of great length. Furthermore, the angular movement of the beam of light reflected from the concave mirror is twice that of the beam of the balance. The position of the scale *a* may be varied. Raising it increases the length of the scale for a unit weight.

There has long been a prejudice against displacement balances and one reference book, which deals, in part, with weighing machines, states that they are not practical nor accurate. We have met with similar discouragement during the several years we have been attempting to perfect our balance. The failure of the many arrangements we tested was due to the displacement liquid used. Mercury, which, at first thought, would appear to be well suited for this purpose, due to the fact that it will not wet the metal of the plunger or cup, has a low vapor pressure at room temperature and low coefficient of expansion. Mercury, however, has a high surface tension which precludes its use. Pure water, also, has a high surface tension and can not be used. Organic liquids with low surface tensions have high coefficients of cubical expansion which causes some inaccuracies in the balance since the movement of the plunger, and in turn that of the light beam on the scale, depends upon the density of the liquid which changes with the temperature. The properties that an ideal displacement liquid should have are: Low surface tension, low vapor pressure, low viscosity, and low thermal coefficient of expansion.

Water has low viscosity and low coefficient of expansion but it has high surface tension and vapor pressure. However, for some time we used water for the displacement liquid by adding a thin layer of high boiling-point kerosene to reduce the interfacial tension between the water and the metal of the plunger and cup. The evaporation of the water which necessitates frequent additions to the supply in the cup is objectionable. We finally selected a pure organic liquid as the best one available for use in the displacement cup. It has low viscosity, vapor pressure, and surface tension, but, in common with other organic liquids, has a higher coefficient of thermal expansion than water. The variations in the movement of the image of the lamp filament on the scale caused by the change in density of the displacement liquid has been overcome by installing a threaded rod *j* on the arm which carries the pointer and by placing a movable threaded weight *k* on the rod. The deflection of the beam of any balance for a given difference in the loads on the pans varies directly with the distance between the central knife-edge and the end knife-edge and inversely with the weight of the beam and the distance of the center of gravity of the beam below the central knife-edge. Therefore, raising the center of gravity of the beam system increases the deflection. Thus the scale may be lengthened or shortened by moving the weight *k*. The rapidity with which a balance returns to its position of equilibrium after being displaced is influenced by the position of the center of gravity of the beam. In an ordinary balance the center of gravity of the beam must be below the knife-edge, but in our balance it may be above or below because the stability is controlled by the plunger assembly. The weight *k* may be adjusted readily but this need be done only when there is considerable variation in temperature. The change in density of the displacement liquid with temperature variations will cause changes in the rest point of the balance which may be compensated for by means of the adjusting screws. Adjustments due to this cause may have to be made more frequently than the adjustment of the length of the scale. With the present arrangement, the smallest amount of liquid which can be used and still allow the plunger to operate should be placed in the displacement cup.

We are using the balance to weigh accurately to

0.05 gram. The scale and plunger are of such dimensions that 10 grams is indicated on the scale. The loads on the pans have to be balanced to within 10 grams and then the excess in weight is indicated on the scale. However, the scale and plunger can be changed to increase or decrease the portion of the weight which is automatically indicated on the scale. It is rather simple to calculate the diameter of the plunger necessary to give an even multiple or an aliquot part of the scale, and the plungers may be interchanged readily. Since the length of the scale can be changed by adjusting the weight k, the calculation of the diameter of the plunger does not have to be exact. We have replaced and used the plunger shown in the sketch with a smaller one so that the entire length of the scale indicates 2 grams only, instead of 10 grams.

The scale divisions are equally spaced throughout the entire length of the scale. The total movement of the beam of the balance is through a relatively small angle, about 5° 55′, and for such an angle the error introduced by equally spacing the scale division is negligible. The scale a may be made flat instead of being shaped in the form of an arc, but it is necessary to arc the scale in the balance shown to keep the image of the lamp filament sharply focused throughout the entire range of the scale. On the analytical balance mentioned below we use a flat scale. Another change in the construction of this balance is in the adjustment for the change in rest point due to the contraction or expansion of the displacement liquid which is made by shifting the scale.

Our device has been installed also on an analytical balance of 200-gram capacity. A difference in loads on the weighing pans of 1,000 milligrams or less is indicated on the scale, and the scale can be read easily to 5 milligrams, but it is possible to make the balance more sensitive than this.

The balance has been proven to be simple to construct and operate. It is accurate, and since the movement of the indicating beam of light may be altered at will and the plunger may be interchanged to give different values to the scale divisions, it is extremely flexible and may be employed for a wide variety of weighings. We have found the balance to be very useful in preparing samples of definite weight, since the amount of material to add after the approximate quantity has been placed in the weighing cup is indicated on the scale. The fatigue of weighing is reduced with our balance, and the speed of weighing is greatly increased.

F. J. Veihmeyer
C. H. Hofmann
C. V. Givan

University of California

SECTIONING ORBITOID FORAMINIFERA[1]

This fall, wanting to make some careful studies of several different Orbitoids, of which there was only one specimen each available, it was necessary to develop a new technique in order to get both equatorial and vertical sections from the same specimen, the ordinary technique requiring more than one individual.

The technique developed is applicable to all Orbitoids ranging in size above 3 mm in equatorial diameter. The method is as follows:

The specimens were first freed of matrix. Then a common cork about 25 mm in diameter (Fig. 2) was

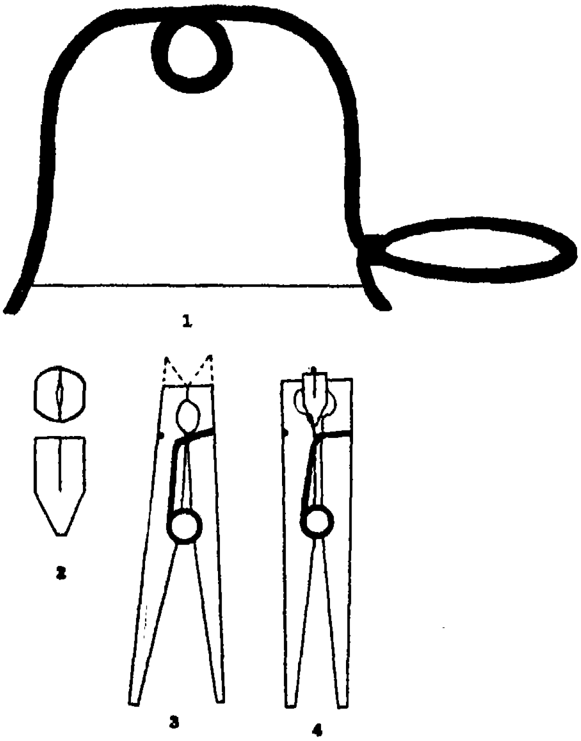


Fig. 1. Fret saw strung with wire. 2, Cork cut to hold specimen. 3, Spring clothes pin with ends cut off as shown by dotted line. 4, Clothes pin, cork with specimen in place to cut.

slit with a sharp blade about two thirds of the way down the center and the sides cut off parallel to the center cut. The lower part was then beveled off to allow it to be grasped in a common spring clothes pin. It is necessary to select a good cork and to cut it parallel with the grain.

The specimen was placed in the cut in the cork for about one half its diameter, the rest sticking out. Then an ordinary spring clothes pin with the ends cut off, as in Fig. 3, was used to hold the cork plus the specimen. I found it best to force a slight depression in the sides of the cork against the specimen so

[1] Method developed during some work done under a grant from the National Research Council.

as to hold it better. Care must be exercised in placing the Orbitoid in the cork so that when the specimen is cut the embryonic apparatus is not damaged. For cutting, a common fret saw frame (Fig. 1) was strung with a piece of No. 10 B & S gauge copper wire under slight tension. This with F.F.F. carborundum and plenty of water was used to cut off a portion of the test. The cut was made as close to the center as possible without damaging the embryonic apparatus. This cutting can be judged only from experience in handling specimens. The wire cuts the test quickly and easily and if due care is exercised in handling the saw, the sawed surface is relatively plane and smooth. The portion cut off is used for a vertical section.

The larger part containing the embryonic apparatus was then mounted in Canada Balsam, as is usually done in making equatorial sections. This part was then ground down on a fine hone; stopping every few strokes to make a Camera Lucida tracing. When the equatorial plane was reached a final tracing was made and measurements of the various parts taken. The Orbitoid was reorientated in additional Canada Balsam as for a vertical section and another series of tracings made, until the embryonic apparatus is again bisected. The cut-off part is then used to make a vertical section in the usual way. There is left a complete vertical section and a piece of the specimen with two polished surfaces; an equatorial and a vertical plane.

The series of Camera Lucida tracings were then drawn on separate sheets of celophane by means of India ink and studied. I have found this method of great use in the study of deformed Orbitoids, especially one that had a twin growing up from one surface. This method is rapid and sure, and it gives a convenient way to study the various chambers of the "larger foraminifera."

WILLARD BERRY

OHIO STATE UNIVERSITY

SPECIAL ARTICLES

A POSSIBLE PHYSIOLOGICAL INTERPRETATION OF THE LAW OF THE DIMINISHING INCREMENT

WORKERS in animal nutrition have long felt the need for some satisfactory means of expressing mathematically the relation between growth and feed consumption. The interpretation of the results obtained in many feeding experiments is often complicated by differences in the amounts of feed consumed by the lots which are being compared. Obviously, it would be very desirable to have some means of calculating the true efficiency of any given feed for growth, regardless of the amounts of feed consumed by the experimental animals.

The applicability of the law of the diminishing increment to the problem of describing the relation between feed consumption and live-weight of growing animals was demonstrated by Spillman.[1] More recently Jull and Titus[2] have shown that the equation as given by Spillman is a fairly accurate means of expressing the live-weight of growing chickens as a function of feed consumption. Titus[3] showed that the growth of ducklings can be described by the equation equally well. Beyond pointing out the fact that each successive gain in live-weight for an equal increment of feed intake tends to bear a constant ratio to the gain immediately preceding, neither of the above-mentioned investigators offered any explanation to account for the relationship.

The differential form of the equation of the curve of the diminishing increment is:

$$\frac{dW}{dF} = k(A - W) \qquad (1)$$

which merely states that the gain in live-weight per unit of feed intake is directly proportional to the difference between some constant and the live-weight already attained. The constant A has been interpreted to represent the mature weight of the animal, since when growth ceases,

$$\frac{dW}{dF} = 0, \text{ and } W = A.$$

No matter how accurately this equation may describe the relation between feed consumption and growth, it throws very little light upon the physiological processes involved unless some rational explanation is presented to show why the equation fits the facts.

It is common knowledge among workers in animal nutrition that the feed intake of a growing animal is utilized essentially in two different ways. One portion is used to supply the fuel required to carry on the metabolic activities of the animal and may be designated as the maintenance requirement.* The other portion is used for growth and part of it is retained and incorporated into the body tissues, pro-

[1] W. J. Spillman and Emil Lang, "The Law of Diminishing Returns," World Book Co., Chicago, 1924.

[2] Morley A. Jull and Harry W. Titus, "Growth of Chickens in Relation to Feed Consumption," *Jour. Agr. Res.*, 36 (6): 541–550 (1928).

[3] Harry W. Titus, "Growth and the Relation between Live-weight and Feed Consumption in the Case of White Pekin Ducklings," *Poultry Sci.*, 7 (6): 254–262 (1928).

* This, of course, includes the energy requirements for all voluntary muscular activity.

ducing a gain in live-weight. It is self-evident that if no feed were required for maintenance and if the fraction of the feed incorporated into the body tissues was always of the same chemical composition, the live-weight of a growing animal would be a linear function of feed consumption. Expressed mathematically the relation would be:

$$\frac{dW}{dF} = C \tag{2}$$

Since some feed is used for maintenance and the amount required for this purpose is known to increase as the animal becomes larger, $\frac{dW}{dF}$ can not be constant but must be some diminishing function of live-weight. It is necessary in this connection to express the amount of feed used for maintenance in terms of a loss of body tissues. If it is assumed that the loss in live-weight per unit of feed consumed is proportional to the live-weight of the animal, we may express the relation between feed consumption and growth as follows:

$$\frac{dW}{dF} = C - mW \tag{3}$$

When this equation is rewritten in the form:

$$\frac{dW}{dF} = m\left(\frac{C}{m} - W\right) \tag{4}$$

it becomes identical with equation (1) for $m = k$ and $\frac{C}{m} = A$.

The integral forms of equations (1) and (4) are, respectively:

$$W = A - Be^{-kF} \tag{5}$$

$$W = \frac{C}{m} - Be^{-mF} \tag{6}$$

in which e is the base of the natural system of logarithms and B is derived from the constant of integration. As pointed out by Spillman, B represents the total possible gain in live-weight of which the animal is capable between its initial live-weight and its weight at maturity.

In accordance with the assumptions made in deriving equation (6) certain conclusions may be drawn from the constants in equation (5). Obviously kA represents the gain in live-weight which the animal is capable of making for each unit of feed eaten if no feed were required for maintenance, for it is readily apparent from equations (5) and (6) that $kA = C$. In other words, kA represents the true efficiency of the feed for growth. It is interesting to note that $\frac{1}{k}$ represents the amount of feed which would have been required for the animal to reach its mature weight if no feed had been required for maintenance, for $kA \cdot \frac{1}{k} = A$ and A represents the live-weight of the animal at maturity.

This interpretation of the law of the diminishing increment may be employed for the purpose of estimating the maintenance requirement of a growing animal at any stage of growth. Let W_1 represent the live-weight of the animal when it has consumed F_1 units of feed. If no feed had been used for maintenance, the live-weight would have been $kA \cdot F_1 + W_0$, in which W_0 represents the animal's initial live-weight. The number of units of live-weight which have been lost because of the maintenance requirement while the animal was attaining the weight W_1 is, therefore, $kA \cdot F_1 + W_0 - W_1$. Since a gain in live-weight of one unit is equivalent to $\frac{1}{kA}$ units of feed, the maintenance requirement, expressed in units of feed, is $F_1 + \frac{W_0}{kA} - \frac{W_1}{kA}$. Similarly, the total amount of feed which has been used for maintenance by the time the animal reaches another live-weight, W_2, is $F_2 + \frac{W_0}{kA} - \frac{W_2}{kA}$. Therefore, the amount of feed used for maintenance during the time the animal is consuming the increment of feed, $F_2 - F_1$, is

$$F_2 - F_1 - \frac{W_2 - W_1}{kA}$$

Jull and Titus, in their work on "Growth of Chickens in Relation to Feed Consumption," give the results of fitting the equation of the curve of the diminishing increment to data obtained from four lots of cross-bred chickens, obtained by mating Barred Plymouth Rock females with Rhode Island Red males. Two of the lots consisted of pullets and two of cockerels, the sexes being separated at hatching time. Although all four lots were fed the same diet and received the same treatment, the duplicate lots did not eat the same amounts of feed. However, the values of kA calculated from the fitted equations agree very well for the duplicate pens as the accompanying table shows.

According to these values the cockerels were able to make better use of the feed for growth than the pullets.

Some idea of the reliability of these results can be obtained by comparing them with a value obtained for white Leghorn pullets recently reported by Titus.[4] In determining the gross maintenance requirement

[4] Harry W. Titus, "The Gross Maintenance Requirement of White Leghorns." *Poultry Sci.* 8(2): 80–84 (1928).

VALUES OF kA CALCULATED FROM EQUATIONS OBTAINED BY JULL AND TITUS

Lot	Sex	A	k	kA (Efficiency of feed for growth)
		Kilograms		
1	Females	3.0726	.0970791	.298
2	Females	3.6084	.0817604	.295
3	Males	4.9142	.0710867	.349
4	Males	4.1954	.0873561	.366

of a group of White Leghorn pullets, having an average live-weight of 1,632 grams, Titus found that a gram loss in live-weight was equivalent to about 3.45 grams of feed. Taking the reciprocal of this value, a gram of feed is found to be equivalent to .290 grams of body tissue. This value agrees very well with the corresponding values calculated for the cross-bred pullets by means of the equation of the diminishing increment.

The writers have calculated the maintenance requirements of chickens at various ages from the above-mentioned data, using the method described above. They appear to be of reasonable magnitude but, unfortunately, no experimentally determined values are available with which to check the results.

If the fundamental assumption that the fraction of the feed incorporated into the body tissues is always of the same chemical composition is valid, the maintenance requirements must be correct. By rewriting equation (3) in the form:

$$dW = C \cdot dF - mW \cdot dF \tag{7}$$

it is readily apparent that the time relationships are as follows:

$$\frac{dW}{dT} = C \cdot \frac{dF}{dT} - mW \cdot \frac{dF}{dT} \tag{8}$$

The maintenance requirement of an animal at any particular time is, according to this equation, proportional to the product of the live-weight of the animal and the amount of feed ingested, which agrees with the well-known fact that the heat production of an animal is increased as its plane of nutrition is raised. During the actively growing period the chemical composition of the animal probably does not change sufficiently to introduce any great error into the calculations.

In view of the number of possible factors which may affect the maintenance requirement of an animal and the relative lack of refinement of the conditions under which feeding experiments are ordinarily carried on, the expression of the maintenance requirement as given in equations (3) and (8) is probably as justifiable as any other proposed up to the present time. However, it should be regarded as being merely a tentative approximation to the true mathematical relationships involved. A better equation expressing the relation between feed consumption and growth can doubtless be evolved when more information regarding the metabolism of the growing animal is available. Until such information is available the law of the diminishing increment may be of much help in the interpretation of the results of a feeding experiment.

WALTER A. HENDRICKS
MORLEY A. JULL
HARRY W. TITUS
BUREAU OF ANIMAL INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

THE RÔLE OF COPPER IN THE SETTING AND METAMORPHOSIS OF THE OYSTER

THE most important and critical period in the life history of the oyster is that during which the fully developed larva cements itself to some clean submerged surface such as old shells or stones and then undergoes a metamorphosis into a spat and adult oyster. The term setting is applied to this process of attachment, which is a biological reaction of a most positive character requiring a definite chemical stimulus for its initiation. A study of the setting reaction under natural conditions in Milford Harbor, Connecticut, showed that it occurred during the low water stage of the tide or, in other words, when river discharge had its greatest effect on the physical and chemical condition of the water over the oyster beds. The environment of the oyster is exceedingly complex from a physical and chemical standpoint, and at periods of low tide we find the extremes of many factors as the mixing of fresh and salt water is taking place. Experiments with the oyster larvae under controlled laboratory conditions showed that changes in temperature, salinity, hydrogen-ion concentration, oxygen content, CO_2 tension and water pressure would not induce in a single instance the setting reaction. However, if in reducing the salinity, river water was used instead of distilled water, the larvae gave a positive setting reaction, which indicated that there was some substance in the river water which served to stimulate and control their attachment and metamorphosis. Further experiments involving variations in the amount and proportion of the cations and anions of the neutral salts were found to be ineffective in producing setting of the larvae, as were also the compounds of iron, zinc, tin, lead, aluminum, manganese and silver. The only element of those tested that produced a positive setting reaction was copper in the form of a pure metal or as a carbonate, sul-

phate or chloride. This heavy metal was effective in concentrations of one part copper to 25 million or 50 million parts of sea water and initiated almost immediately the setting process. In the river water, copper was found to be present in amounts varying from 0.2 mg to 1.25 mg per kilo, and is apparently the specific element that is necessary for the attachment, metamorphosis and survival of the oyster. River water from which the copper had been removed by precipitation and filtration was no longer effective in producing setting.

Conditions in Milford Harbor, Connecticut, were unusually favorable during the past summer for the setting of oyster larvae, so that it was possible to determine under natural conditions the relation between the time and intensity of this reaction and the copper content of the water. Several series of observations were made covering complete tidal cycles, one of which is shown for July 22 in the following figure.

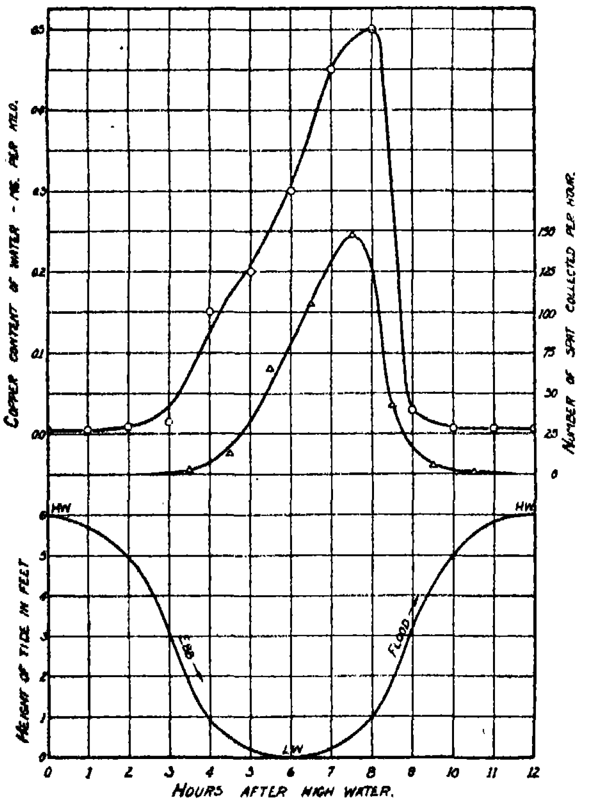


FIG. 1. Relation between the copper content of the water and the setting of oyster larvae.

The intensity of the setting was determined through the use of standard partition collectors for oyster seed, 12 of which were planted under uniform conditions at the time of high water and removed singly every hour thereafter to ascertain the number of spat which they had gathered during each interval. The difference in the number of spat collected from hour to hour shows the relative intensity of setting, during each period, which can be closely correlated with the copper content of the water. A concentration of approximately 380 spat was found on collectors which were left in the water during this complete tidal cycle, and of this number over 97.5 per cent. had become attached during the period when the copper content of the water ranged from 0.15 mg to 0.50 mg per liter.

The water of highest copper content is found in Milford Harbor in the surface layer shortly after the time of low water, while in other regions this relationship may vary according to the existing hydrographical and tidal conditions and thus produce differences in the distribution of oysters and heavy setting areas. The sudden rise in the copper content of the water on the first of flood tide, as shown in the accompanying figure, was due to the upstream movement of water from the Indian River which continues to run ebb into the harbor near the mouth, for an hour or two while the tide there is running flood. Samples of water from the Indian River showed a copper content ranging from 0.8 to 1.2 mg per liter, which clearly accounts for its effectiveness in stimulating the swimming and setting of oyster larvae during low water and the first two hours of flood tide. At the time that this water was passing over the tidal flats there occurred on five acres of this area the setting of over 100 million oyster larvae. However, as the tide rose rapidly above the two-foot mark, the flow from Indian River stopped, as did also the setting of the larvae when they were subjected to water having a higher salinity and a very low copper content of less than 0.01 mg per liter.

Cytological studies of the larvae showed that during its development there were gradually being deposited near the liver two dark green pigmented bodies which disappeared with its metamorphosis into the adult form. These pigment spots on closer examination were found to consist of a mass of densely packed cells, containing numerous green-colored granules, which with the beginning of the setting reaction were observed to gradually break apart and migrate into the blood stream. Approximately 300 of these deeply pigmented cells came from each pigment spot and exhibited such structural and functional characteristics as to identify themselves as the leucocytes of the spat and adult oyster.

Copper plays an important rôle in the respiratory processes of the oyster, and its assimilation by the larva would serve to increase the oxygen-carrying capacity of the blood and release cells during the metamorphosis for carrying out this function, both of which would greatly facilitate its rapid growth and development into the adult form.

Though copper, like other heavy metals, may have a beneficial and stimulating effect in infinitesimal amounts, it will in slightly higher concentrations quickly produce cytolysis and death of the oyster larva.

These studies indicate that in the development, distribution and survival of marine animals traces of certain mineral elements in their environment are of considerable biological significance and may constitute some of the chief limiting factors.

By the use of copper in the form of a pure metal or salt, it was possible in 1928 to observe in detail for the first time the setting and metamorphosis of the oyster larva, a brief description of which has been given in Bureau of Fisheries Document No. 1068 (Progress in Biological Inquiries, 1928).

Herbert F. Prytherch
U. S. Bureau of Fisheries

EXPERIMENTS IN TERMITE CASTE DEVELOPMENT

For many years two main theories have been invoked to explain the production of termite castes. According to one set of advocates the important factors are seated in the germ plasm, while an equally illustrious group of investigators maintain that the worker and soldier castes at least owe their origin to environmental agencies. For several months I have been conducting a series of experiments whose results appear to be pertinent, but as some years will probably elapse before the completion of the work this note is published in the hope that students may be induced to study other species, especially those in which the worker caste is represented.

The material serving as a basis of these experiments are the Pacific Slope species, *Termopsis angusticollis* and *T. nevadensis,* in which only soldiers are developed during the first four years. When, in other words, the colony is approximately four years old, and comprises about four hundred soldiers in various stages of development a few winged individuals, representing the reproductive caste, put in an appearance. As the population increases the two classes gradually become equally represented, and often in old nests, where the food supply is running low, the reproductive caste is practically the only one present. Furthermore, the first soldier developed in a new colony is probably in the fifth instar. The second one is undoubtedly in the sixth, and as the community enlarges the number of molts increases until in long established societies the adult soldiers are in the ninth instar. No exception is known to the rule that the winged or perfect insects make their first appearance only at a point where the soldiers are in the eighth instar. Caste development in the case of *Termopsis,* for the first four years at least, is thus a well-ordered, gradual and invariable series of events, judging by a careful examination of scores of colonies.

It has been demonstrated in the case of certain other insects that within limits the number of molts is dependent upon temperature or the food supply. In the present instance temperature appears to be of minor importance. On the other hand, when the colony is small the food administered to the young is obviously limited, and the fact that the increase in the number of molts bears a fairly definite relation to the increasing number of attendants strongly suggests that food is the important factor. The following experiments also lead to the same general conclusion.

Several large colonies of both species of *Termopsis* were selected in which the reproductive and soldier castes were equally represented. In some cases they were headed by the original king and queen, which were isolated and placed in an experimental jar. An examination six months later showed in every instance that these individuals had died without making an effort to construct a burrow. The remaining colonies were headed by from three to twenty-one substitute or neoteinic royal insects. When the number of these was five or less they were removed from each colony and placed in a separate jar; where the number was larger they were divided into groups of not more than five. Thirty-six such lots have been kept under observation for a period of from two to two and one half years. Four of these died during the period of experimentation; the others evidently set to work almost immediately on the construction of burrows, and evidently commenced to produce young during the first six months. From time to time an individual colony was preserved and measurements taken.

The results show conclusively that when these small groups of kings and queens are deprived of attendants they cease abruptly to produce members of the reproductive caste, and develop soldiers only. And furthermore, the important fact appears that the first soldiers are in the fifth and sixth instars, and the number of molts increases in proportion to the growth of the population. In short, the history of the young colony, headed by a few royal neoteinic insects, is exactly the same as that of the young colony normally headed by the winged king and queen. There is nothing obvious in these experiments which suggests germ plasm as an important factor; rather it appears to be a question of quantitative or possibly qualitative feeding.

Harold Heath
Hopkins Marine Station,
Pacific Grove, Calif.

DIOECIOUS MAIZE

IN contrast to the higher animals most seed plants are hermaphroditic, having male and female sex organs either in the same flowers or in different flowers on the same plant. There are a number of species of plants, both cultivated and in the wild, that have the two types of flowers in different individuals and correspond, functionally, to the situation in the higher animals. How this condition may have been brought about naturally is illustrated by the change that has been made under experimental control whereby the normally monoecious maize has been changed to a dioecious plant.

A recessive gene called silkless, found in a self-fertilized progeny of flint corn, renders the normal pistillate inflorescence, commonly called the ear, devoid of silks. The ovaries with their styles and stigmas are aborted and the result is a barren cob enclosed in the usual husks. These silkless plants have normal tassels and good pollen and are functionally male plants.

Another hereditary factor is known which changes the terminal staminate flower or tassel of corn into a seed-bearing structure. These "tassel-seed" plants, since they produce good seed but no pollen, are functionally female plants.

Crossing these pistillate and staminate individuals gives normal hermaphrodites in the first generation. These plants, when self-fertilized, segregate in the following generation as expected of such a dihybrid. A majority of the resulting plants are normal hermaphrodites; a smaller number are typical silkless or male in function; and approximately an equal number are typical tassel-seed plants, female in function.

What form the double recessive, silkless-tassel-seed plants would have, with both abnormal factors in the homozygous condition, was a matter of much speculation. Such individuals might be sterile in both types of flowers and consequently neuter in function. They might be sterile in the lateral inflorescence and fertile in the terminal inflorescence. There were other possibilities but the latter result seemed to be the most probable outcome. If this proved to be the case it was thought possible to produce a dioecious corn.

In a large number of progenies segregating for both factors, grown in successive years, no plants which looked like a recombination of both genes were found. All the tassel-seed plants produced at least a vestige of a lateral ear and when these were examined they were all seen to have silks. This particular tassel-seed factor was known to be on a different chromosome from the one carrying silkless so that linkage did not prevent the recombination.

A number of second generation tassel-seed plants, carrying silkless either in one or two doses, were crossed by silkless plants heterozygous for tassel-seed. Forty-one progenies of such matings were grown and five were found to give only two types of plants—male and female. These five families were entirely dioecious, their seed parent having produced only seed and their pollen parent only pollen. In a total of 86 plants, 37 were female type and 49 male type.

From these results it was quickly apparent that the reason the doubly recessive plants, having both silkless and tassel-seed genes, were not recognized was due to the fact that they were no different in appearance from the singly recessive tassel-seed plants. Apparently tassel seed has the ability to nullify the action of the silkless gene and allows the plants to produce seed both in the tassels and in the lateral ears. On this assumption such a plant would carry silklessness in double dose and when crossed by a silkless plant that was otherwise normal would give all silkless plants. This result has practically been obtained. Out of 30 plants from such a cross, 29 were all completely silkless. There was one exceptional plant, possibly due to contamination. It would be difficult to account for it by segregation since, in that case, half of the plants should have been silkless.

There seems to be no other way to account for the five families of dioecious corn than that the mother plants with seeds in the tassel were also homozygous for silkless. Whatever the explanation, the fact is that a dioecious strain has been produced from a monoecious species. The female plants are homozygous, the male plants are heterozygous, and natural pollination of one by the other is expected to continue to give only male and female plants in approximately equal numbers. In this way an hermaphroditic organism has been changed to a separate-sexed organism.

DONALD F. JONES

CONNECTICUT AGRICULTURAL
EXPERIMENT STATION

BOOKS RECEIVED

BOONE, LEE. *Bulletin of the Vanderbilt Marine Museum.* Volume III, Scientific Results of the Cruises of the Yachts "Eagle" and "Ara" 1921–1928, William K. Vanderbilt, Commanding. Pp. 221. 83 plates. Vanderbilt Marine Museum, Huntington, Long Island, New York.

DELPORTE, E. *Atlas Céleste.* Pp. 26. 13 plates. Cambridge University Press, Macmillan. $3.00.

DULL, CHARLES E. *Modern Chemistry.* Pp. xii + 776. 392 figures. Henry Holt. $1.80.

NORTHROP, F. S. C. *Science and First Principles.* Pp. xiv + 299. Macmillan. $3.00.

OLDEKOP, EWALD. *Über Das Hierarchische Prinzip In Der Natur Und Seine Beziehungen Zum Mechanismus-Vitalismus-Problem.* Pp. 64. F. Wassermann, Reval.

PHILLIPS, E. P. *South African Grasses.* Pp. 224. 121 plates. Central News Agency, South Africa.

POOR, VINCENT C. *Electricity and Magnetism.* Pp. ix + 183. Wiley. $2.25.

SCIENCE

VOL. 73 — FRIDAY, APRIL 24, 1931 — No. 1895

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

MICHAEL FARADAY[1]

By Dr. W. F. G. SWANN

BARTOL RESEARCH FOUNDATION

IT is a characteristic of the march of progressive in natural philosophy that from time to time we seem to see the end of all that man may hope to learn. There arises before our mental vision a barrier, a barrier in which the horizon of knowledge seems also its boundary. The things that have not already been done seem trivial, or at best so hopelessly complex and involved in relation to our previous fields of thought that nothing but discouragement and waste of time offer themselves as the probable lot of any one who seeks to unravel them.

The tremendous development in electrical science which has taken place in the last hundred and fifty years acts in two diametrically opposite ways in moulding our appreciation of the contributions to science of such a man as Michael Faraday. On the one hand they emphasize to us the fundamentality of his work. They emphasize the fact that it is to investigations made for merely altruistic reasons that the world must look, ultimately, for returns in the form of material progress in the applications of science to everyday life. If we could picture that kindly philosopher who worked in his laboratory a century ago as having a prophetic vision of the results of his labor, we might suppose him well encouraged by the vision of the future in the many discouragements of his present. Wide as was his vision, however, we can hardly imagine that even Faraday could foresee the glorious maturity to which his efforts have grown to-day. To him those strange phenomena concerned with the behavior of light, those effects produced by the mutual motions of magnets and wires, those curious powers possessed by certain fish to give

[1] An address given on February 14, 1931, at the Massachusetts Institute of Technology, under the auspices of the Department of English and History.

electric shocks when touched, and so forth, had every right to appear as a set of more or less heterogeneous phenomena giving little guarantee of anything but much labor and frequent discouragement in their study. It is easy, to-day, to imagine a sort of guardian angel who might have guided the hand of Faraday to do those particular experiments and adopt those particular view-points which most rapidly would have led to a vision of what the future held forth; but even this guardian angel would have required the support of an army of mechanicians and workers of all sorts and kinds if his suggestions were to be of much service. The present-day investigator who would appreciate the greatness of Faraday as an experimenter must put himself in the atmosphere of Faraday's time. He must clear out all the machinery from his workshop, dispense with all his stocks, deprive himself of all electrical supply houses and almost every other kind of a supply house, leaving himself with only his bare hands and a few simple tools. Then he must deny himself all the encouragement to be gleaned from the experiences of successes in the past, and must look only forward into a dark cloud in which are but a few vague glimmers of light. His comforts to be obtained from a picture of the past must be little more than can be obtained from a contemplation of the discovery that if a black ebonite rod be rubbed with the skin of a cat, it will acquire the power to pick up small pieces of paper, and to exhibit a blue glow, visible only in the dark, these powers being hindered by the presence of water. What a suspicious set of phenomena! For black rods, cats and witches have been associated from time immemorial. The effect of the water would provide the cynic with much wherewith to whet his sarcasm when he recalled the oft reiterated appeal to that mythical triumvirate, earth, fire and water. And then, the blue light visible only in the dark adds no great prestige to the phenomena. Nor is such encouragement to be expected from the possible value of the phenomena. For it is perfectly evident that if one should kill all the cats in the world and rub all the black rods in the world with the skins of all the cats the most that one could hope to do would be to pick up a few collar studs. It was in such a setting of the almost immediate past that Faraday commenced his work. He did not have the encouragement which we should have to-day from the fact that the history of the past suggests the probability of success in undertaking the investigation in some unexplored field. To one who contemplates the position of electricity in the economy of our life to-day, it seems a most extraordinary thing that these vast powers could have lain hidden for the whole history of civilization when all the time there existed on this same earth the wherewithal to make a dynamo.

Michael Faraday was born at Newington Surrey, England, on the 22nd of September, 1791. His father was a blacksmith and from such history of him as is recorded we learn that he was a hard working, deeply religious man and a firm adherent to that particular sect of non-conformity to the Episcopal church known as the Sandemanians. Europe was in the throes of Napoleonic war, food was scarce, and Faraday himself records that his bread allowance was limited to one loaf per week. The family moved to London when Faraday was five years of age. Little is known of his schooling, but at the age of thirteen we find him engaged as errand boy to a book seller. At this period, newspapers were only for the wealthy, and even then they were hired and not bought. It was Faraday's duty to convey them from one place to another. In the following year his master, Mr. Riebeau, took him as an apprentice to the trade of bookbinding which he carried on in addition to his profession of book selling. The opportunity thus provided for the young Faraday to come into contact with books seems to have been the first means of firing his interest in science. The "Encyclopaedia Britannica" provided him with his first notions on the subject of electricity and a book, "Conversations of Chemistry," by a Mrs. Marcet, gave him his first introduction into chemistry. Writing later concerning his mental attitude at this time, Faraday says:

> Do not suppose that I was a very deep thinker, or was marked as a precocious person. I was a very lively imaginative person, and could believe in the "Arabian Nights" as easily as in the Encyclopaedia. But facts were important to me, and saved me. I could trust a fact, and always cross-examined an assertion. So when I questioned Mrs. Marcet's book by such little experiments as I could find means to perform, and found it true to the facts as I could understand them, I felt that I had got hold of an anchor in chemical knowledge, and clung fast to it. Thence my deep veneration for Mrs. Marcet—first as one who had conferred great personal good and pleasures on me; and then as one able to convey the truth and principle of those boundless fields of knowledge which concern natural things, to the young, untaught, and inquiring mind.

In connection with his activities as a bookbinder's apprentice, young Faraday came into contact with many interesting and prominent people and through the kindness of one of them, a Mr. Nance, who was a member of the Royal Institution, he was provided with the opportunity of hearing four of Sir Humphry Davy's lectures. This was in 1812, when he was twenty-one years of age. In the meantime his enthusiasm for science had grown, and he seems to have been determined by hook or by crook to become a philosopher, the term which, by the way, he always liked to apply to a student of physics. The word

physicist was particularly distasteful to him. Having made careful notes of the four lectures, he sent them to Sir Humphry with a letter asking for some kind of employment of a scientific nature, however humble it might be. We learn that Davy seems to have been frankly puzzled by the unusual request. "What am I to do?" he asked one of the managers of the institution. "Do," the other retorted, "Put him to wash bottles; if he is good for anything he will do it directly, if he refuses he is good for nothing." Davy seems to have adopted a kindly and sympathetic attitude toward the young enthusiast. He failed not to point out to him that the life of a philosopher was likely to be no bed of roses, and that he would do well to weigh the advantages in the regular and definite nature of his occupation as a bookbinder, of which he was now a master, as against the uncertain livelihood which he might expect as a devotee of science. However, the young philosopher was not to be dissuaded, and a few months later when a situation became vacant at the Royal Institution it was offered to Faraday and was immediately accepted. The minute of the meeting of the board at which the appointment was confirmed is as follows:

> Sir Humphry Davy has the honor to inform the managers that he has found a person who is desirous of occupying the situation lately filled by William Payne. His name is Michael Faraday. He is a youth of twenty-two years of age. As far as Sir H. Davy has been able to observe or ascertain he appears well fitted for the situation. His habits seem good; his disposition active and cheerful; and his manner intelligent. (March, 1813.)

And so at the age of twenty-two, and at a weekly wage of 25 shillings, Faraday began that career whose fruits were a revolution in civilization greater than has ever been made by any king, conqueror or empire. It is not without interest to contemplate the state of mind of the great investigator at this early period in his career. He seems to have pondered upon many things, and to have formed concerning them opinions which are very surprising for their maturity when one meditates upon the limited opportunities for coming into contact with a world, which he must have had at this time. An apparently little known comment of his upon the art of scientific lecturing, written in the form of a letter, at the early age of twenty-one, might well serve as a guidance to many of us to-day. I wish I could read the whole letter to you, but I must content myself with a few extracts. After commencing with a statement of how he came to put down his thoughts upon the subject he goes on to dilate upon the matter of arriving at a lecture late which he considered "an impropriety of no small magnitude and indeed bordering on an insult to the lecturer." He goes on to discuss the ventilation of the lecture-room. He writes:

> There is another circumstance to be considered with respect to a lecture-room of as much importance almost as light itself, and that is ventilation. How often I have felt oppressive in the highest degree when surrounded by a number of others and confined in one portion of air! How have I wished the lecture finished, the lights extinguished, and myself away, merely to obtain a fresh supply of that element! The want of it caused the want of attention, of pleasure, and even of comfort, which were not to be regained without its previous admission. Attention to this is more particularly necessary in a lecture-room intended for night delivery, as the lights burning add considerably to the oppression produced on the body.

Then later we read:

> The fitness of subjects, however, is connected in an inseparable manner with the kind of audience that is to be present, since excellent lectures in themselves would appear absurd if delivered before an audience that did not understand them. Anatomy would not do for the generality of audiences as the Royal Institution, neither would metaphysics engage the attention of a company of schoolboys. Let the subject fit the audience, or otherwise success may be despaired of.

Even at this early age he had evidently sensed out several well-known groups of people among whom were to be found the superficially learned, when he writes, "A lecturer may consider his audience as being polite or vulgar (terms I wish you to understand according to Shuffleton's new dictionary), learned or unlearned (with respect to the subject), listeners or gazers." And when at the end of the paragraph he writes, "Lastly, listeners expect reason and sense, whilst gazers only require a succession of words."

An example of his rather caustic wit is found when he remarks:

> With respect to the action of the lecturer it is requisite that he should have some, though it does not here bear the importance that it does in other branches of oratory; for though I know of no species of delivery (divinity excepted) that requires less motion, yet I would by no means have a lecturer glued to the table or screwed on the floor. He must by all means appear as a body distinct and separate from the things around him, and must have some motion apart from that which they possess.

Nevertheless, he has little sympathy with theatricalism, as when he writes,

> Let your experiments apply to the subject you elucidate, do not introduce those which are not to the point. Though this last part of my letter may appear superfluous, seeing that the principle is so evident to every capacity, yet I assure you, dear Abbot, I have seen it broken through in the most violent manner—a mere ale-

house trick has more than once been introduced in a lecture, delivered not far from Pall Mall, as an elucidation of the laws of motion.

During the period of his apprenticeship we find him already engaged upon scientific experiments. The language in which he writes of them shows an interesting mixture of humility and confidence. In the case of a young man feeling his wings in the fields of science we frequently find either a superficial arrogance or a timidity of judgment which seems to call for the comfort of approval of some older head to give it confidence. In Faraday, at this time, we find the most perfect equanimity of judgment combined with a boyish enthusiasm of irresistible freshness. To most people natural philosophy is a mysterious sort of thing which is accommodated in a special part of the brain kept clean for study and unhampered by the phenomena of every-day life. But to young Faraday, the phenomena of science are just like everything else. He describes his discoveries as one would tell the story of a human episode. The byways of knowledge are to him like the lanes through a beautiful wood. There is to him a real beauty in the things which he sees, and to seek a utilitarian purpose, at least in the line of his own benefit, is as far out of mind as it is for one who walks through a beautiful forest and enjoys the scent of the trees and beauty of the flowers to seek a reason to cut the trees for lumber or pluck the herbs for the market. Writing to his friend Abbot, he says, "I have lately been thinking a few simple galvanic experiments." He describes his purchase of materials and goes on to describe the conception of a voltaic pile:

The first I completed contained the immense number of seven pairs of plates!!! And of the immense size of halfpence each!!!! I, Sir, I my own self, cut out seven discs of the size of halfpennies each. I, Sir, covered them with seven halfpence, and I interposed between seven, or rather six, pieces of paper soaked in a solution of muriate of soda! But laugh no longer, dear Abbot; rather wonder at the effects this trivial power produced. It was sufficient to produce the decomposition of sulphate of magnesia—an effect which extremely surprised me; for I did not, could not, have any idea that the agent was competent to the purpose. A thought here struck me, I will tell you. I made the communication between the top and bottom of the pile and the solution with copper wire. Do you conceive that it was the copper that decomposed the earthy sulphate—that part, I mean, immersed in the solution? That a galvanic effect took place I am sure; for both wires became covered in a short time with bubbles of some gas, and a continued stream of very minute bubbles appearing like small particles ran through the solution from the negative wire. My proof that the sulphate was decomposed was, that in about two hours, the clear solution became turbid; magnesia was suspended in it.

And so he goes on still with his enthusiasm to describe several other experiments of similar character. Then mixed up with his thoughts on philosophy, we find, at this time, a mature consideration of other things. Writing his friend Abbot, he exlaims:

What a singular compound is man! what strange contradictory ingredients enter into his composition, and how completely each one predominates for a time, according as it is favoured by a tone of the mind and senses, and other exciting circumstances! At one time grave, circumspect, and cautious; at another, silly, headstrong, and careless;—now conscious of his dignity, he considers himself a lord of creation, yet in a few hours will conduct himself in a way that places him beneath the level of beasts; at times free, frivolous, and open, his tongue is an unobstructed conveyer of his thoughts—thoughts which, on after-consideration, make him ashamed of his former behaviour; indeed, the numerous paradoxes, anomalies, and contradictions in man exceed in number all that can be found in nature elsewhere, and separate and distinguish him, if nothing else did, from every other created object, organized or not.

Almost immediately after Faraday's appointment to the Royal Institution, Sir Humphry Davy planned an extensive European trip for the purpose of conferring with the learned scientific men of the continent. He took Faraday with him in the capacity of a sort of combination of valet and scientific assistant, in which complex situation he was not at all times as happy as he might have been. Writing his friend he remarks:

I am quite ashamed of dwelling so often on my own affairs, but as I know you wish it, I shall briefly inform you of my situation. I do not mean to employ much of this sheet of paper on the subject, but refer you to the before mentioned long letter for clear information. It happened, a few days ago before we left England, that Sir H's valet declined going with him, and in the short space of time allowed by circumstances another could not be got. Sir H told me he was very sorry, but that, if I would do such things as were absolutely necessary for him until he got to Paris, he should there get another. I murmured, but agreed. At Paris he could not get one. No Englishmen were there, and no Frenchmen fit for the place could talk English to me. At Lyons he could not get one; at Montpellier he could not get one nor at Genoa, nor at Florence, nor at Rome, nor in all Italy; and I believe at last he did not wish to get one: and we are just the same now as we were when we left England. This, of course, throws things into my duty which it was not agreement, and is not my wish, to perform, but which are, if I remain with Sir H, unavoidable. These, it is true, are very few; for having been accustomed in early years to do for himself, he continues to do so at present and he leaves very little for a valet to perform; and as he knows that it is not pleasing to me, and that I do not consider myself obliged to do them, he is always as careful as possible

to keep those things from me which he knows would be disagreeable. But Lady Davy is of another humor. She likes to show her authority, and at first I found her extremely earnest in mortifying me. This occasioned quarrels between us, at each of which I gained ground, and she lost it; for the frequency made me care nothing about them, and weakened her authority, and after each she behaved in a milder manner. Sir H has also taken care to get servants of the country, ycleped *lacquais de place*, to do everything she can want, and now I am somewhat comfortable; indeed, at this moment I am perfectly at liberty, for Sir H has gone to Naples to search for a house or lodging to which we may follow him, and I have nothing to do but see Rome, write my journal and learn Italian.

His description of the various incidents of the journey are rich with interest and detail, and betray that sense of humor which must have served him in good stead on many an occasion in the uphill path of his earlier years. He describes his arrival in France:

I was in hope of going on shore, but understood that no one could leave the ship until the arrival of an officer to examine us. Late in the afternoon the mighty men of office came, attended by several understrappers and a barge full of Frenchmen, apparently beggars and porters. A formal examination then ensued. One of the officers came to me, taking my hat off, he first searched it, and then laid it on the deck; he then felt my pockets, my breast, my sides, my clothes, and lastly desired to look into my shoes; after which I was permitted to pass. A similar ceremony was performed on all the strangers; and though I felt surprised at such a singular reception, I could hardly help laughing at the ridiculous nature of their precautions.

Then later he goes on to say:

The various parts of the carriage, the boxes, packages, etc., being placed on deck, word was given and immediately the crew of Frenchmen poured on them, and conveyed them in every direction, and by the most awkward and irregular means, into the barge alongside, and this with such an appearance of hurry and bustle, such an air of business and importance, and yet so ineffectually, that sometimes nine or ten men would be around a thing of a hundred pounds' weight, each most importantly employed; and yet the thing would remain immovable until the crew were urged by their officer or pushed by the cabin boy.

On November the second he writes, "The streets of Paris are paved with equality—that is to say, no difference is made in them between men and beasts, and no part of the street is appropriated to either; add to this that the stones of which the pavement consists are very small and sharp to the foot, and I think much more need not be said in praise of it"—and so on. On the ninth he describes his difficulties concerning passports. On the 13th, he visits the church and ends with the remark, "A theatrical air spread through the whole, and I found it impossible to attach a serious or important feeling to what was going on." On the 23rd he starts off "MM. Ampère, Clement, and Desormes came this morning to show Sir H. Davy a new substance, discovered about two years ago, by M. Courtois, saltpetre manufacturer." Then he goes on to speak of the properties of this new substance, iodine. On the 24th, he dilates upon the domestic economy of the English as compared with the French houses and ends with the remark, "French apartments are magnificent, English apartments are comfortable; French apartments are highly ornamented, English apartments are clean; French apartments are to be seen, English apartments enjoyed; and the style of each kind best suits the people of the respective countries." And so, describing everything in detail, he goes on to talk of philosophy, travel, art, politics and everything that comes under his enthusiastic vision.

On his return to the Royal Institution, Faraday took up his duties as Davy's assistant. Davy was at the height of his activity, and his researches at this period included those on fire damp in coal mines which resulted in the invention of the celebrated Davy safety lamp. With the limited facilities at the disposal of the investigator at this time, the labor of carrying out experiments was enormous and most of the burden must have fallen upon Faraday. In addition he was soon called upon to act as assistant for the various lectures at the Institution, and his duties involved a preparation of lecturing experiments. He was evidently exceptionally skilful in this capacity for we read that "He who has the good fortune to have Faraday for his assistant is lecturing on velvet." At the same time he labored to extend his own knowledge in all directions, through his own reading, through attendance at the lectures and through contact with Davy and the men of learning who visited his laboratory. But it was through his own experiments that he seems to have learned most. He had, in an outstanding degree, that characteristic so frequently found in the born experimenter, the desire to repeat experiments which have been done before, as a preliminary to proceeding to extend them further. It is said that he never felt satisfied that he had obtained all that could be obtained from a recorded observation unless he himself had repeated it; and that it seems that he would hardly trust himself to reason from an experiment unless he himself had performed it with his own hands. When in 1821 he wrote an account of all that was then known of electro-magnetism, he was not satisfied with the mere quotation of the experimental results obtained by others, but

repeated with his own hands the great majority of experiments upon which the subject rested at that time. As his knowledge and experience grew, he found time to carry out original work on his own account, and his first paper, "An Analysis of Naturally Occurring Caustic Lime," appeared in the *Quarterly Journal of Science* in 1816, when he was about twenty-five years old. He speaks of having published this paper "With my fear greater than my confidence and both far greater than my knowledge; at a time also when I had no thought of ever writing an original paper on science." The paper was well received and was followed by others on chemical subjects. Two years later he wrote a paper on sounding flames in which he demonstrated an error in the theory of the great Professor De la Rive.

In the year 1820, Oersted discovered that a wire carrying a current possessed the power to influence the magnet in a curious way. The discovery appears to have been more or less of an accident, and the nature of the force between the wire and current was quite a mystery, since the force did not act in a line joining the wire to the magnet. Following upon this discovery Ampère had shown, in the most brilliant way, that, as regards its power to produce a magnetic field, a wire carrying a current was the equivalent of a magnetic shell whose boundary was the current, and he traced out in great detail the system of forces between the current elements which would be the equivalent of the forces between the circuits carrying the currents. In Maxwell's eulogy of this masterly achievement of Ampère he writes:

> The experimental investigation by which Ampère established the laws of the mechanical action between electric currents is one of the most brilliant achievements in science. The whole, theory and experiment, seems as if it had leaped, full grown and full armed, from the brain of the "Newton of electricity." It is perfect in form, and unassailable in accuracy, and it is summed up in a formula from which all the phenomena may be deduced, and which must always remain the cardinal formula of electro-dynamics.

I can not here resist continuing Maxwell's statement a little further, in his comparisons of the methods of attack of Ampère and Faraday. He writes:

> The method of Ampère, however, though cast into an inductive form, does not allow us to trace the formation of the ideas which guided it. We can scarcely believe that Ampère really discovered the law of action by means of the experiments which he describes. We are led to suspect, what, indeed, he tells us himself, that he discovered the law by some process which he has not shown us, and that when he had afterwards built up a perfect demonstration he removed all traces of the scaffolding by which he had raised it. Faraday, on the other hand, shows us his unsuccessful as well as his successful experiments, and his crude ideas as well as his developed ones, and the reader, however inferior to him in inductive power, feels sympathy even more than admiration, and is tempted to believe that, if he had the opportunity, he too would be a discoverer. Every student should therefore read Ampère's research as a splendid example of scientific style in the statement of a discovery, but he should also study Faraday for the cultivation of a scientific spirit, by means of the action and reaction which will take place between the newly discovered facts as introduced to him by Faraday and the nascent ideas in his own mind.

These discoveries were of overwhelming interest to Faraday. He collected and repeated all the experiments which had been performed bearing upon the effect and published his account of the progress of electro-magnetism in the *Annals of Philosophy*. The force between the current and the magnetic pole was like no force that had ever been discussed before. Instead of being in the line adjoining the pole to the current it was perpendicular to that line. Dr. Wollaston thought that he could convert the deflection of the needle by the current into a continuous rotation of needle around the current, and he also hoped to devise means by which the current could be made to rotate around the magnet. With these objects in view he carried out tests in the presence of Sir Humphry Davy, at the Royal Institution, but without success. The difficulty in the case of the rotation of the magnet arises of course from the existence of the two poles. If one passes the current through a wire which goes through the center of the magnet in the direction perpendicular to the axis, there is as much tendency to rotate the North pole in one sense as there is to rotate the South pole in the opposite sense, and consequently no rotation takes place. On the other hand, if one places the magnet again with its axis perpendicular to the wire carrying the current, but at some distance from the current, one might suppose that the greater proximity of one pole to the wire would result in the tendency to turn that particular pole in one direction overbalancing the tendency to turn the other pole in the opposite direction. However, the differences in the two forces on the pole is just compensated as regards the rotational effect by the greater moment per unit of force when the force is applied at a greater distance from the axis of the rotation, and again no rotation takes place. By the adoption of an ingenious device by which the current is caused to divide into two channels in such a way that during the revolution of the magnet the current is transferred from the channel in front to the channel in the rear so that the middle of the magnet can pass through the current without stopping it, Faraday succeeded in realizing to his

great delight the extremely interesting achievement of causing a magnet to rotate about a current. He also succeeded in devising an apparatus by which a current was caused to rotate around the pole of the magnet and in principle therefore the germ of the modern motor was conceived.

In 1821 Faraday married, and was accorded permission to bring his young wife to live at the Royal Institution. The Royal Institution of Great Britain was founded by Count Rumford, in 1799. Its stated purpose was "The promotion, diffusion, and extension of science and of useful knowledge." In the early period of its history it was financially in rather low water, and there was probably a feeling to the effect that its activity should be devoted as far as possible to the discovery and development of phenomena which promised an early return for the benefit of mankind. In 1821, Faraday commenced a series of experiments to improve the quality of steel used in surgical instruments; and, in 1825, the Royal Society called upon his services in the matter of improving the manufacture of glass. Much labor was spent in this type of work until 1829 when in a dignified letter to the Royal Society he begs to go free to follow the light within him and to work out his own thought upon other subjects. Of these semi-commercial activities, the most notable was his invention of a certain type of heavy glass. It was not so much for the purpose for which it was intended that it became famous, as in the fact that it later constituted the material in which he discovered the rotation of the plane of polarized light under the influence of a magnetic field. During this period Faraday acquired a fame such that his value was particularly recognized in the commercial field; and, presumably he would have had no difficulty in making himself a comparatively rich man had he been willing to sacrifice his time to such purposes. We learn that in the year 1830 he earned, by chemical analysis, an addition to his income of more than a thousand pounds and in 1831 a still greater addition. His friend, the great physicist, Professor John Tyndall, who was in a position to know the circumstances, estimates that by 1832 he had only to will it to raise his professional income to five thousand pounds. His decision to concentrate his efforts on pure science, however, resulted in his income falling from about a thousand pounds in 1831 to a hundred and fifty-five pounds in 1832, from which it fell with slight oscillations to ninety-two pounds in 1837 and to zero in 1838. Between 1839 and 1845 Tyndall informs us that, except in one instance, it never exceeded twenty-two pounds. However, during this period of his commercial activity, he managed to make worthy contributions to the field of pure science; and, in 1823 he succeeded in liquefying chlorine. The phenomenon occurred while heating, at the suggestion of Sir Humphry Davy, a certain solid hydrate of chlorine in a steel tube. The hydrate had been recently discovered, and the nature of its constitution was a question of interest at the time. The solid fused at blood-red heat and the tube became filled with a yellow gas. A certain Dr. Paris who happened to enter the laboratory while Faraday was performing the experiment jokingly accused him of working with a tube contaminated with oil. The next morning he received from Faraday a letter, "Dear Sir: The oil you noticed yesterday turned out to be liquid chlorine." In subsequent years there seems to have been some jealousy on the part of Sir Humphry Davy in the matter of this particular experiment. It is true that Davy suggested heating the substance, but there is no great evidence to show that he expected the result which was obtained. That the oily liquid was chlorine was a matter figured out by Faraday for himself, however much it may have been in the mind of Davy as a possibility. Following this discovery Faraday succeeded in liquefying several of the other so-called permanent gases and removed that distinction which had so far existed between gases and vapors, a distinction founded upon the belief that the latter were the only ones which were capable of liquefaction. These experiments were not without danger, and we learn on one occasion that no less than thirteen pieces of glass found their way into Faraday's eye, luckily without permanent injury.

In 1823, Faraday was elected a fellow of the Royal Society. At that time Sir Humphry Davy was president, and it is a regrettable fact that he actively opposed Faraday's election, presumably as a result of the matter concerning the credit for the liquefaction of chlorine. In 1825 Faraday was elected director of the laboratory. His first act showed a desire to promote the welfare of the members. He invited them to come to evening meetings in the laboratory, and it was from these evenings that the first Friday evening discourses of the Royal Institution had their origin.

In 1832 the managers of the Royal Institution, still in financial difficulties, after mature consideration came to the conclusion that they could not recommend a reduction in Faraday's stipend which, amounting as it did to one hundred pounds per annum with house, coals and candles, was already at what seemed to be an irreducible minimum. In the following year, however, a Mr. Fuller founded at the institution the professorship of chemistry, which is known by his name, and the institution, which was fully alive to Faraday's value, hastened to show its appreciation by electing him to the first Fullerian professorship for life, at the same time relieving him from the necessity of having to give any lectures unless he so desired.

(To be concluded)

SCIENTIFIC EVENTS

THE IMPERIAL AGRICULTURAL RESEARCH BUREAUS

THE *Journal* of the Australian Council for Scientific and Industrial Research gives a summary of the first annual report of the executive committee concerning the organization and objects of the eight new Imperial Agricultural Research Bureaus. Their function as defined by the 1927 Imperial Agricultural Research Conference, which recommended their formation, is to facilitate the collection and dissemination of scientific information among the agricultural research workers of the empire.

The executive council itself is composed of nominees of the different governments of the empire, and it elects its own chairman and appoints its own officers. To that extent the organization of the bureaus is somewhat unique, in that in a technical sphere of work the administrative direction of activities for a common empire purpose is vested in a body composed of nominees of the governments, and not in one of His Majesty's governments acting on behalf of all governments.

The eight bureaus, namely, those of soil science, animal nutrition, animal health, animal genetics, animal parasitology, plant genetics (herbage plants), plant genetics (other than herbage plants) and fruit production have now been fully organized and are all actively functioning. Their location at existing research institutes has enabled them to operate economically and efficiently. The various institutes have placed accommodation at the disposal of the bureaus on generous terms, and have assisted in numerous other ways, but particularly by making their libraries freely available, and by allowing their officers to give advice and help on particular inquiries. Although the bureaus were established only recently, several of them were able, before the close of the year, to commence the distribution (at first in mimeographed form) of information in their particular branches of agricultural science. For instance, the Bureau of Animal Nutrition has issued a collection of reprints of special interest to investigators, and also a summary of research work on animal nutrition now in progress throughout the empire; the Bureau of Soil Science has issued a number of "technical communications," particularly in regard to soil classification; and the Bureau of Animal Genetics is issuing a quarterly journal containing a number of articles which would ordinarily be quite inaccessible to research workers in the more distant parts of the empire.

Another object of the bureaus is to facilitate arrangements for research workers granted "study leave" to undertake well-thought-out courses of further study and investigation. All the directors of the bureaus would be glad to advise any investigators interested. Another function on which the executive council and the directors lay special stress is that of promoting in every way possible direct contacts between officers of the bureaus and research workers overseas. To further this end, an officer who has either received part of his early training or has served for some time in some portion of the empire overseas, has been selected in almost every case for the post of chief officer under the directors. The executive council hopes that research workers who contemplate visiting the United Kingdom in any year will inform the appropriate bureau of their intention. It also hopes that they will visit the bureau, where they will be assured of a hearty welcome.

MINERAL VALUES IN ALASKA

AN effort to determine the mineral values of Alaska will be carried out this summer by the Department of the Interior. The recent Congress appropriated $250,000 "for continuation of the investigation of mineral and other resources of Alaska," along the Alaska Railroad. This is in addition to the regular appropriation for work in Alaska.

The appropriation was placed in the hands of Secretary Wilbur and the work has been organized through the U. S. Geological Survey. Though this special appropriation is not available until July 1, the Geological Survey, considering the short working season in Alaska, has arranged to make advances from its own funds that the work may be started early and a full season of results attained.

Sixty thousand dollars has been allocated to Willow Creek, Fairbanks, Copper Mountain, Girdwood, Kantishna and Moose Pass districts, and a party will operate in each of these areas. Twenty-four thousand dollars have been allocated to the West Fork of Chulitna, Valdez Creek, Talkeetna Mountains and Yentna districts and the investigators will form four parties. To investigate, test and report on nonmetallic minerals such as clay, limestone, marl, etc., in the railroad belt, and prepare a pamphlet on their economic value and possibilities of production $5,000 has been set aside. It is estimated that the surface investigation of the Anthracite Ridge coal field will cost $27,000, and that the core drilling in that field will cost $100,000.

As the purpose of the investigation is to develop natural resources along the Alaska Railroad, it is important that the results of the examinations shall be published as quickly as possible after the field work has been completed. To this end the Geological Sur-

vey will prepare at Anchorage memoranda for publication, setting forth the principal results of the individual investigations within a few weeks after the field work of the parties has been completed. Complete statements of the field results of each project, based on a more thorough study on material collected and on the interpretation of many technical observations will follow later, but will be issued at as early a date as is compatible with a thoroughly sound and accurate statement of the results.

For the above purposes the Anthracite Ridge area has been temporarily withdrawn from classification. The other areas where the ten parties will operate will not be withdrawn or in any way reserved, and this intensive work to produce tonnage will be carried on in the most promising areas, both on the public lands and with the permission of the owners on claims which are already staked. No development work will be done, but the testing of samples and intensive geological work will give the owners, prospectors and prospective investors some guide as to the possibilities of the property under study.

The Geological Survey will maintain throughout the year a representative in Alaska, with headquarters at Anchorage, to work with prospectors and mining companies, and make available to them the material gathered by the surveys herein provided. His salary and the expenses of his office will be charged against the $250,000 appropriation mentioned. He will also be a medium of coordination between the railroad and the other agencies engaged in this program. The General Land Office will aid in making surveys of the areas investigated.

THE FOREST SERVICE AND HIGHWAY COMMISSIONS

THE Forest Service of the Department of Agriculture, in instructions issued to its regional foresters, announces that hereafter there will be the fullest cooperation with the Federal and State Highway Commissions in the interest of preservation of roadside beauty and other natural scenery. The instruction read:

A. All national forest lands within 200 feet of the center line of a Class A or Class B highway, or within 100 feet of the center line of a Class C highway or road shall be administered with the major objective of conserving or augmenting the scenic, inspirational, educational and recreational values of said lands and roads, and no form of occupancy or use of said lands or the products thereof shall be allowed except with the prior approval of the regional forester or forester who, before granting such approval, shall require full assurance that proposed [illegible] is necessary, is appropriately safe[illegible] not result in a sacrifice of public [illegible] greater than the public values or ser[illegible] from such occupancy or use.

B. While the proposal to acquire all timbered lands contiguous to highways by granting national forest stumpage in exchange therefor is regarded by the Forest Service as impracticable, the acquisition of areas of privately owned forest land, within the boundaries of the national forests, for the purpose of conserving roadside beauty, will be accomplished as rapidly as such lands can be acquired through exchange with due regard to other requirements of public interest.

C. The detailed and systematic planning of the management and use of all national forest lands tributary to class 1, 2 and 3 roads, including not only the 400- or 200-feet strips, but also such other additional lands as may affect the public value of a given road, will be regarded as a definite and current administrative function of the Forest Service, to be carried to consummation as rapidly as the available personnel, funds and other administrative obligations will permit. National park approach roads will be given initial consideration. Project plans will be personally considered by the regional forester and when approved by him will thereafter govern all occupancy and use of the lands involved.

D. An effort to secure the approval of Congress to the employment of a limited technical personnel for the more intensive management and development of the scenic and recreational potentialities of the national forests, in which major attention would be given to the relation of the highway and road system and its adaptation to the natural values involved.

LECTURES IN PHYSICS AT THE UNIVERSITY OF MICHIGAN

THE department of physics, University of Michigan, announces the following special lectures for the summer session of 1931:

PROFESSOR ARNOLD SOMMERFELD, University of Munich.

Electron Theory of Metals. (First half.) Introduction to the Fermi-Dirac statistics. Richardson Effect. Problems of Conductivity. Thermoelectric and thermomagnetic effects. Problems of specific heat.

Selected Problems of Wave Mechanics. (Second half.) Photoelectric effect, especially with x-rays. Advancing of the radiation maximum for different shells. Continuous x-ray spectrum. Diffraction of electron rays.

PROFESSOR W. PAULI, University of Zurich.

Problems of Nuclear Physics. (First half.) Application of the theory of potential thresholds to nuclear disintegration. Nott's theory of impact of alpha particles on helium. Nuclear spin and band spectra. Hyperfine structure, especially of ionized lithium. The electric quadrupole moment of the nucleus.

Application of Quantum Theory to Problems of Thermal Equilibrium. (Continuation of Electron Theory of Metals.) (Second half.) H theorem. Ferromagnetism. Conductivity of metals at low temperatures. Influence of space lattice forces upon thermoelectric effects.

PROFESSOR H. A. KRAMERS, University of Utrecht.

Quantum Mechanics and Classical Models. (First half.) Vector models for atoms and molecules. Rotation of polyatomic molecules.

PROFESSOR W. F. COLBY, University of Michigan.

Theory of Band Spectra. A development of the problem of molecular spectra. This course will cover the recent work, both in classification and theory of radiation from molecules.

PROFESSOR GEORGE E. UHLENBECK, University of Michigan.

Application of the Theory of Probability in Physics. This course will contain a detailed treatment of the fluctuation-phenomena, of the theory of Brownian motion, and of their recent applications.

PROFESSOR J. R. OPPENHEIMER, California Institute of Technology.

General Quantum Theory of Transitions. (First half.) Methods for investigation of elementary collisions. Interaction between radiation and matter.

PROFESSOR OTTO LAPORTE, University of Michigan.

Quantum Theory of Atomic Spectra. A study of the structure of atomic spectra from the theoretical viewpoint. Interaction of electrons within the atom. Laws governing term separations. Hyperfine structure.

THE BOTANICAL SOCIETY OF AMERICA

THE Botanical Society of America will this year hold two summer meetings: it will participate in the summer meeting of the American Association for the Advancement of Science at Pasadena, California, and it will hold an eastern meeting at Pennsylvania State College, State College, Pennsylvania.

The Pasadena meeting will be held from June 16 to 20. Regular sessions will be held in the mornings beginning on Tuesday, June 16. Excursions to places of special interest will be made in the afternoons.

Botanists will find the Pasadena region full of interest; the parks and gardens abound with tropical and subtropical exotics; the mountains, desert and sea are easily accessible and exhibit an unusually diversified native flora.

In addition to the afternoon excursions arranged by the association, the Botanical Society will conduct a week-end (June 19–21) field-trip to places of special botanical interest, if enough botanists wish to go.

Those planning to participate in the meetings must forward the title and a short abstract of their papers so as to reach the chairman of the program committee not later than May 4. A request for a lantern, if desired, should also be made at that time.

The chairman of the program committee is Dr. L. R. Abrams, Stanford University, California.

The eastern meeting will be held from Tuesday, June 16, to Friday, June 19. On the evening of the sixteenth there will be a general gathering, followed by an address and an informal reception. The next three days will be devoted to an inspection of the experimental work in botany conducted at the College Experiment Station, to field trips, to round table discussions on various topics, and to demonstrations of scientific material by members of the society. On Thursday there is planned an all-day trip to Bear Meadows and the Alan Seeger Monument. The country around the college is diversified botanically and these trips should be of particular interest.

The meeting will be informal in character throughout and no scientific papers will be presented. Members remaining over for Saturday or the week-end will have opportunity for additional field trips, the privileges of the Country Club, or of cabins in the mountains, with a choice of golf, trout fishing and other diversions.

State College may be conveniently reached by rail, but is most readily accessible by motor car over good roads from all directions.

Suggestions as to topics for discussion and requests for space and apparatus for demonstrations should be sent to the chairman of the local committee, Professor Frank D. Kern.

SCIENTIFIC NOTES AND NEWS

AT the annual meeting of the National Academy of Sciences, in Washington, D. C., an evening lecture will be given on April 27 by Professor James H. Breasted, of the University of Chicago. The subject is "The Rise of Man and the Dawn of Research."

THE John Scott Prize of the City of Philadelphia, consisting of a bronze medal and $1,000, has been awarded to Orville S. Peters, Chevy Chase, Maryland, for his invention of the electric telemeter. Dr. Peters was from 1910 to 1918 assistant physicist at the Bureau of Standards.

THE doctorate of science will be conferred by the Georgia School of Technology on Mr. Harry F. Guggenheim "in recognition of his high standing in the scientific engineering and aeronautical fields." The occasion of the conferring of the degree will be the formal dedication at commencement on June 6 of the Daniel Guggenheim School of Aeronautics.

PRESIDENT MASARYK, of Czechoslovakia, has conferred the Order of the White Lion, Fourth Class, on Dr. Frederick G. Novy, professor of bacteriology and chairman of the executive committee of the Medical School of the University of Michigan.

THE French Government has named Jerome Alex-

ander, consulting chemist of New York City, Officier de l'instruction publique.

We learn from *Nature* that the prize for 1930 for an improvement in the science or practice of navigation offered by the Royal Society of Arts, under the terms of the Thomas Gray Memorial Trust, has been awarded to Messrs. Charles A. Stevenson and David Alan Stevenson, of Edinburgh, for their invention of the talking beacon installed at Cumbrae Lighthouse.

Museum News states that Mr. R. Lawford Knaggs has been awarded the honorary medal of the Royal College of Physicians, London, in appreciation of his services to the museum of the college.

At the annual meeting of the American Association of Pathologists and Bacteriologists held in Cleveland, on April 2, the following new officers were elected: Ward J. MacNeal, *president;* E. T. Bell, *vice-president;* F. B. Mallory, *treasurer;* Howard T. Karsner, *secretary;* O. T. Avery, *incoming member of council.*

At the meeting of the Royal College of Physicians of London held on March 30, Lord Dawson of Penn was elected president, in succession to Sir John Rose Bradford, Bt.

Dr. C. W. Hungerford, professor of plant pathology, assistant dean of the College of Agriculture and vice-director of the Agricultural Experiment Station of the University of Idaho, has been appointed dean of the Graduate School, effective on June 1.

Industrial and Engineering Chemistry reports that Mr. W. F. Fulton has left the Palmer Gas Products Corporation, Shreveport, Louisiana, to become head of the chemical department of the United Gas Public Service Company, Houston, Texas, where he is in charge of all laboratories of the system.

Edwin C. Boudreaux, who has been acting chief of the New Orleans station, Food and Drug Administration, for the past year, has been appointed chief of that station. Mr. Boudreaux has directed the work there since the death, in 1925, of A. L. Burns, former chief.

The Committee on Scientific Research of the American Medical Association has made a grant-in-aid to Dr. H. E. Himwich, of the department of physiology, of Yale University, for aid in work on fat metabolism in diabetes.

Dr. John M. T. Finney, professor of clinical surgery at the Johns Hopkins University School of Medicine, has been appointed consultant to the committee on the costs of medical care.

Professor George Tischler, of the University of Kiel, will serve as Speyer Professor at the Johns Hopkins University during 1931–32. He will be in residence in Baltimore from November 1 to January 31. For a short time before and after his stay in Baltimore, Professor Tischler expects to be able to lecture in other institutions in this country. Any institution wishing to hear Professor Tischler should communicate directly with him at Kiel, or with Dr. Duncan S. Johnson, the Johns Hopkins University, Baltimore, Maryland.

Mr. George J. Miller, since 1913 a member of the department of geography of the State Teachers College at Mankato, Minnesota, will give a course of lectures at the University of London during the spring of 1931. These lectures, which will treat primarily of geographic education in American schools and the geography of the United States, will be offered in three of the colleges of the university, the London Day Training College, Birkbeck College and the London School of Economics and Political Science.

Among the speakers at the formal dedication on April 20 of the School of Medicine and Hospital of Duke University were Dr. David Linn Edsall, dean of Harvard Medical School; Dr. Lewis Hill Weed, director of the Johns Hopkins School of Medicine; Dr. William Henry Welch, of the Johns Hopkins; Dr. Watson S. Rankin, of Charlotte, director of the division of hospitals of the Duke endowment; Governor O. Max Gardner, of North Carolina, and Dr. Thurman D. Kitchen, of Wake Forest College.

President Karl T. Compton, of the Massachusetts Institute of Technology, will address the West Virginia University Scientific Society on May 12. His subject will be "The Spirit of Inquiry." On Wednesday, May 13, he will speak to the students at the convocation exercises upon "Engineering and Industry."

Professor Oskar Baudisch, of the department of chemistry of Yale University, addressed the Physics Seminar at Purdue University on April 2 on "The Formation of Gamma Ferric Oxide and Its Magnetic Properties."

Professor L. E. Dickson, of the University of Chicago, gave illustrated lectures on March 2 before the Western Society of Engineers and on April 4 before the American Mathematical Society on "The First Complete Proof of a Waring Theorem on Fifth Powers."

Professor R. D. Carmichael, of the department of mathematics of the University of Illinois, addressed the Sigma Xi Club of the University of Alabama on April 23. His subject was "Some Recent Advances in Mathematical Thinking."

Dr. Robert Robison, head of the department of

biochemistry of the Lister Institute, London, will deliver a lecture on "The Chemistry of the Calcification of Bone" at the Hospital for Joint Diseases, New York, on May 7 at 8:30 P. M. This is the first lecture given under the auspices of a fund established in the memory of the late Dr. Walter M. Brickner.

AT the meeting of the Section of Diseases of Children of the Royal Society of Medicine, London, to be held on June 9, Professor A. Calmette, of Paris, will read a paper on the B.C.G. immunization of infants.

ON the evening of April 22 Dr. E. P. Wightman, of the Kodak Research Laboratories, Rochester, New York, addressed The Camera Club, New York, on the subject of "Photographic Development." On the walls of The Camera Club was hung during the month of April a seventy-two print exhibition of pictorial photographs by Dr. Wightman.

ON April 2 and 3 Dr. A. S. Pearse, professor of zoology, Duke University, lectured at the University of Michigan under the auspices of the department of zoology, on the following subjects: "Tropical Nature," "Migration of Animals from Ocean to Land and Freshwater" and "The Parasites of Nigerian Rodents" and Dr. Robert Chambers, professor of biology at the Washington Square College, New York University, lectured on April 7 and 8 on: "Micro-operations on Living Cells, Plant and Animal," "The Hydrogen-Ion Concentration of Protoplasm," and "Physical and Chemical Properties of Protoplasm."

DR. R. A. FISHER, chief statistician of the Rothamsted Experimental Station, Harpenden, England, will be on the staff of the Department of Mathematics, at the University of Minnesota, during the second half of the summer session, from July 27 to August 29. He will lecture on "The Theory of Estimation" and on "The Statistical Theory of Experimental Design." Professor Griffith C. Evans, of the Rice Institute, will also be in residence at the University of Minnesota during the entire summer session. During the first term, from June 17 to July 25, he will lecture on "The Mathematical Theory of Economics." In the second term he will present the "Potential Theory." The courses of Professor Evans and Dr. Fisher are in addition to the usual summer offerings of the department of mathematics.

IN connection with the celebration in London of the Faraday centenary, planned by the Royal Institution and the British Association of Electrical Engineers, the managers of the Royal Institution would be glad to hear of personal relics, apparatus and manuscripts of Faraday, and those who possess any such objects and are willing to lend them for exhibition are asked to communicate with the General Secretary, Royal Institution, 21, Albemarle-street, W.1.

THE Board of Trustees of Stanford University has received and accepted an offer from an unknown donor to contribute $2,500,000 toward the erection of a building for the Medical School on the condition that the university arrange to endow the same with not less than $1,250,000. The university must raise this sum on or before February 1, 1932.

BY the will of Colonel Henry W. Sackett, authority on libel law, who died December 9, 1929, Cornell University will receive over $500,000. Colonel Sackett graduated from Cornell and was a trustee of the university. The bulk of the bequest is to be utilized for the protection and improvement of the landscape beauty of the campus at Ithaca. Columbia University, where Colonel Sackett lectured, received a $12,000 fund to establish a senior scholarship for the School of Journalism.

DR. JOSÉ ALBERT, professor of the department of pediatrics in the University of the Philippines College of Medicine, Manila, recently gave his private collection of scientific books to the library of the Bureau of Science. This library is said to contain 125,000 volumes, including 600 current medical periodicals and 16,000 medical books and pamphlets.

BY the will of Dr. John E. Teeple, the chemical engineer, who died on March 23, bequests of $10,000 to the Carnegie Institution of Washington, $10,000 to the American Chemical Society, and $20,000 to Cornell University will be received after the death of Mrs. Teeple.

HARVARD UNIVERSITY, Boston, will receive $20,000 by the will of Mrs. Frida Adler, widow of Dr. Isaac Adler, the money to be held in trust and the income used to "provide once in three years a prize for the best piece of original research produced within that period in the United States or Canada on any subject within the medical or allied sciences." The awards are to be known as the Isaac Adler Prizes.

DR. GANESH PRASAD, Hardine professor of higher mathematics in the University of Calcutta and president of the Calcutta Mathematical Society, has handed over to the society notes of the value of Rs. 1,400 for the creation of an endowment for the purpose of awarding a prize and gold medal in memory of his daughter.

GROUND was broken on April 17 for the construction of the Whitney Wing of the American Museum of Natural History by President Henry Fairfield Osborn. This new addition to the museum buildings, which connects with the Roosevelt Memorial under

erection by the State of New York, will be devoted in its entirety to exhibition of oceanic birds and will include aviaries for living birds so that intensive study of their habits may be made, also laboratories and study rooms. The building is due to the generosity of the late Harry Payne Whitney, who donated $750,000 on the condition that the city contribute an equal amount. For eleven years Mr. Whitney maintained an expedition among the South Sea Islands in search of all forms of oceanic and island birds, and during this work there have been secured many species new to science and a number which were hitherto thought to be extinct. This field work, which has been directed by Dr. L. C. Sanford and Dr. R. C. Murphy, has had as leaders in the field such well-known collectors as Rollo H. Beck, Jose G. Correia and Hannibal Hamlin. At the present time Mr. William F. Coultas is at the Island of Kusaie, in the Japanese Mandate region, continuing the work.

Museum News reports that the Royal Ontario Museum, Toronto, has under construction a new wing which will provide over 134,000 square feet of floor space. This will more than double the present floor space for exhibits. The completed structure will resemble the letter "H," the new east wing being connected with the old by a cross bar. The east wing will house the four museums of geology, mineralogy, paleontology and zoology, besides furnishing space for offices, workrooms, storage, lecture rooms, and a tea room. The cross bar and the whole of the existing building, which is to undergo extensive alterations, will be occupied by the museum of archeology. To the south of the cross section, between the two wings, will be built a one-story garden court to house important monumental stone sculptures from China, which have not as yet been on exhibition owing to lack of space. Each of the five museums is readily accessible from the rotunda at the entrance of the new wing. The cost of the new building together with the proposed alterations to the present one will be in the neighborhood of $2,000,000, and will be borne by the Province of Ontario.

THE National Geographic Society, Washington, D. C., has announced plans for an addition to the society's headquarters at Sixteenth and M Streets. The new building will extend along a 135-foot frontage on Sixteenth Street. It will house the society's scientific collections, its library of current geography and rare collection of historic voyages and travels, also the world's largest collection of geographic photographs, and the editorial rooms of its official journal *The National Geographic Magazine*. As designed by Arthur Heaton, architect, and approved by the United States Fine Arts Commission, the additional structure will carry out the general scheme of the older headquarters building in the Italian renaissance style. The central motif will be a colonnade portal and ornamental pediment, with balancing wings of the building on each side.

THE report of the Royal Scottish Museum, Edinburgh, for the year 1930 states, according to the London *Times*, that the attendance of visitors continues to increase, the total for 1930 being 518,369, compared with 516,661 in the previous year. Lectures of an educational character on art and natural history for children of schools under the education authority were attended by 5,708 children in classes, and the museum is becoming more and more the resort, in their leisure hours, of children who have attended the lectures. It is no unusual sight to find little independent groups of children making notes or sketches of the exhibits in the museum. The collection of early scientific instruments gathered from all parts of the continent by the late Sir John R. Findlay is being exhibited in the Armour Hall of the museum. It must rank, the report remarks, as one of the finest collections of such objects, on account of the discrimination and taste shown by the collector.

AN institute of physicochemical biology at Paris was inaugurated recently with fitting ceremonies, according to the *Journal* of the American Medical Association. The institute is a three-story building adjacent to the Radium Institute. Its foundation is due to the generosity of Mr. Edmond de Rothschild, who contributed $2,000,000 to the project. The erection of the building, together with its equipment, has cost $600,000. The institute has large laboratories, well lighted and provided with the most modern equipment. Under the directorship of Professors Jean Perrin, Georges Urbain, Pierre Girard and André Mayer, it will afford the best opportunities for research to physiologists, chemists and physicists engaged in the study of phenomena pertaining to life from the point of view of their particular science. Mr. Edmond de Rothschild, who was a friend of Claude Bernard, hopes in this manner to aid in the realization of the program of study that this eminent physiologist marked out for himself and his successors, namely, to discover the relationships between vital phenomena and physicochemical forces.

THE Board of Trustees of the University of Illinois has adopted new requirements for entrance to the College of Medicine. Hereafter the students admitted must have gained an average of 3.5 in all pre-medical work. This means practically that the students selected will be from the upper third of their classes.

A CORRESPONDENT writes: "There is much variation in the pronunciation of chemical words. One chemist says "ăm′-ĭde," "ā′-quē-oŭs" and "mŏl′-ĕ-cūle," for example, and the next one to speak, unless he is very

polite, is likely to say "ă-mĭde'," "ă'-quē-oŭs" and "mol'-é-cūle." It would be good to have some authoritative standards. Dictionaries differ. Teachers who have occasion to lecture both to student classes and to other audiences and chemists who are being called on to broadcast radio talks are feeling in particular the need for guidance. Accordingly an effort is being made by the Committee on Nomenclature, Spelling and Pronunciation of the American Chemical Society to determine usage for a considerable number of chemical words and with the aid of men experienced in phonetics and other phases of dictionary work it is hoped that some standards can be set up. This effort will require wide cooperation. A questionnaire and a list of words with various pronunciations have been mailed to many chemists. Those who are interested in this subject and would like to help in the work by checking the word list can obtain a copy by writing to the chairman of the committee, E. J. Crane, editor of *Chemical Abstracts*, Ohio State University, Columbus, Ohio."

THE *Journal* of the American Medical Association reports that Senator Guglielmo Marconi, president of the *Consiglio nazionale delle ricerche,* has reported to the Italian prime minister the activities developed during the year by the National Research Council in connection with public health and the program of studies for 1931. The committee on medicine will continue its investigations on irradiated foods, on rheumatism and on ancylostomiasis. It will study, also, the epidemiology of typhoid. The committee on biology has undertaken an inquiry on alimentation, which it will extend on a large scale to various regions and social classes. It will continue also the inquiry on the chemical composition of the food products of Italy, which when completed will permit the compilation of tables showing such composition, which to-day do not exist. On the basis of such tables it will then be possible to recommend suitable rations for the various classes of the civil and military population. The council has called attention to the need of scholarships for research workers, in order that they may devote themselves to scientific research that affects the progress of the nation.

THE sixth annual field course of the International Summer School of Geology and Natural Resources will go west through Canada and return east through the northern United States. The party, which will be led by Professors R. M. Field and Erling Dorf, will leave Princeton on July 27 and return about September 2. Following the established policy of the school, each locality visited will be demonstrated by one or more local authorities. The principal places to be visited are as follows: Silurian section at Niagara Falls; Pleistocene at Toronto; Mines and Pre-Cambrian section at Cobalt; Economic geology, mines and smelter at Noranda; Minaki; general geology of Jasper Park; Pleistocene and Tertiary at Vancouver and Victoria; lumber and forestation at Seattle and Longview; general geology at Spokane; copper mines at Butte; general geology of the Yellowstone Park. The final week of the course will be spent in the Big Horn Basin region, when the party will have an excellent opportunity to study remarkably striking examples of structural and stratigraphic geology. The men eligible for the course include: American university undergraduates who have had at least one course in college geology; American and foreign graduate students, and American and foreign instructors or professors of geology, and professional geologists. Applications should be sent to Professor Richard M. Field, Princeton University.

THE usual field course of the Louisiana State University will be held at Grand Isle, Louisiana, at the foot of Barataria Bay from June 12 to August 12. The group is made up of students from the state and surrounding states and independent workers from other sections who are interested in the gulf fauna and flora. Small problems on research are under way on questions of economic importance to the state; and some results have been achieved with the cooperation of the State Conservation Commission. This summer there will be guest lecturers from other schools in the state.

AFTER a successful trip of about 2,000 miles into the interior from Shanghai, the Marshall Field Zoological Expedition to Southern China has arrived in the mountains above Mouping in the province of Szechwan and begun the collecting of rare animals for Field Museum of Natural History. This was learned on April 2 in a report, dispatched by courier, from Floyd T. Smith, leader of the expedition. Large parts of the journey on the Yangtse River and its tributaries were made in native hand-propelled boats and other long stretches were made afoot. Mr. Smith, who is from Long Island, N. Y., is the only white man on the expedition. He is accompanied by about forty native hunters and skinners. A whole fleet of the small paddled boats was necessary to carry his caravan up the Yangtse, Ya and Min Rivers. On the land sections of the journey a long train of pack animals was employed to carry supplies. An immediate object of the expedition is to collect specimens of the rare goat-antelope called the takin, and one of these animals has already been obtained. Specimens of many other kinds of animals have also been collected. The expedition is to make a systematic survey of several years' duration in a number of provinces of southern China, some of which have never before been thoroughly explored.

DISCUSSION

THE CENTRAL BODIES AGAIN

THE nature of the central bodies or "centrosomes" has previously been discussed in these columns[1] with reference to the question whether they have any existence in the living cell or are merely random granules or artificial products of cytological technique. We will here report briefly the results of studies on the development of the insect egg (*Drosophila*) which, we believe, provide crucial evidence on the question. This object, unexpectedly enough, has been found to offer a spectacular demonstration of the phenomena on a large scale. The cogency of the evidence is due in part to the technical excellence of the preparations, but even more to the prodigious wealth of material which they display. Throughout the syncytial period of development (2,000 nuclei or more), all the nuclear divisions are almost exactly synchronous throughout the egg. At every step, accordingly, all the division-figures (or nuclei) are very nearly at the same stage, so that they may be studied in great numbers, again and again, and in all positions. The evidence thus offered leaves, we think, nothing to be desired in point of either quality or quantity.

It is proper to state that the facts were originally worked out in full by the junior author, who subsequently submitted his extensive series of preparations and photographs to the senior author for further examination. The latter has added only an independent judgment based on critical study of the material, together with the preparation of a large additional series of photomicrographs in which all the essential facts are clearly to be seen. Those facts are, in brief, as follows:

(1) In the metaphase there is at each pole a single, sharply defined central body surrounded by a single aster. In the late metaphase or early anaphase the central body at each pole becomes dumb-bell shaped and divides into two equal parts. Slightly separating, but remaining side by side, the members of each pair pass together during the anaphases to the corresponding pole; and here the pair may lie at any angle, from 90 to 0 degrees with respect to the mitotic axis, precisely as described by a number of the earlier observers. From this point forward the two may easily be followed, without loss of their identity and always clearly separate, throughout the telophases up to the end of the nuclear reconstruction.

(2) During the foregoing stages the pair of central bodies at each pole is surrounded by a conspicuous aster which at every stage remains single, showing no trace of division or the formation of small daughter-asters within the old one. In this respect mitosis in this egg differs from that of such forms as *Chaetopterus, Cerebratulus* or *Thalassema* and is more like that of *Ascaris*.

(3) After the reconstruction both spindle and asters disappear, leaving the two central bodies at each pole lying near the nucleus, and still conspicuously separate. Pictures of this kind, to be seen by hundreds in good preparations at the right stage, exclude even the smallest possibility of confusion with random granules. A little later the central bodies lie very near, or directly upon, the nuclear membrane and now move more widely apart in various degrees. Whatever their final position (whether at opposite poles or less widely separated), each as the prophases approach becomes surrounded by a small clear area and finally by a growing aster.

(4) In later prophases the central bodies move somewhat away from the nucleus, the nuclear wall fades at the nearest points, and here the spindle-fibers are clearly seen growing from the centers into the nuclear cavity. Owing to the varying degrees of divergence of the centers at this time, the incipient spindle is often flexed more or less sharply at its middle point, thus offering interesting V-shaped figures in the later prophases. In the end, however, the spindle straightens out completely and becomes perfectly symmetrical, with a single central body at each pole. The history of these bodies from metaphase to metaphase is thus completed without the slightest breach of continuity at any point.

(5) The foregoing cycle is displayed with unmistakable clearness in the division of great numbers of cells; and every stage, without a gap, has repeatedly been photographed successfully, using the Zeiss 1.5 oil immersion apochromatic and Wratten panchromatic plates.

(6) After formation of the cellular blastoderm, archenteron and mesoblast the mitoses continue to be precisely like those of the preceding syncytial cleavage except that they are smaller and no longer synchronous.

These findings, we believe, establish decisively the following conclusions:

(a) In this object the central bodies are neither random granules, nor artificial products of coagulation of the astral rays, nor staining artifacts; and obviously they do not here serve as blepharoplasts. They are not products of the asters, but, on the contrary, are themselves causally concerned in the formation of the asters.

(b) In this object the central bodies are genetically continuous by division, without the smallest interruption from one cell-generation to another. In this

[1] See the issues of SCIENCE for June 27, 1930, and April 17, 1931.

respect their history in the *Drosophila* embryo, up to a late period of development, is completely in accordance with the classical view maintained by Van Beneden, Boveri, Flemming, Heidenhain, Meves and other early leaders of cytology.

We are convinced that the phenomena in *Drosophila* are in no way exceptional in amphiastral mitosis save in respect to the clearness and profusion of the evidence; and we are confident that intensive and impartial study, using an adequate technique, will demonstrate essentially similar conditions in amphiastral mitoses generally.

The foregoing observations will later be set forth in full, with suitable figures, by the junior author.

EDMUND B. WILSON
ALFRED F. HUETTNER

A NEW POSTERIOR PITUITARY PREPARATION

DURING July and August, 1930, the following method was developed and tested. The resulting material proved to be so different in chemical and pharmacological properties, that a preliminary report was given at the chemistry section of the Cleveland A. A. A. S. meeting.

Fresh beef posterior pituitary lobes are finely ground with a small quantity of sand and transferred to a flask containing about ten volumes of neutral high grade acetone. It is placed in the ice-box and occasionally shaken. New fresh portions of glands are added as obtained from slaughter house, keeping the same acetone ratio. When enough has been obtained to make a convenient batch (100 grams) the material is filtered and fresh acetone is added, shaken frequently and kept at ice-box temperature. Again it is filtered, washed with acetone and once more suspended in 10 volumes of acetone, shaken and cooled as before. The residue from this last acetone treatment is nearly white and dry. Three treatments (each at least 24 hours) with the best grade ether are now used, the procedure being the same as for acetone. Then three additional treatments with high grade petroleum ether. After the last petroleum ether extraction the material is spread out and the occluded solvent evaporated, then returned to the original flask and extracted with ten volumes of a mixture containing methyl alcohol, 70 per cent.; water, 25 per cent.; acetic acid, 5 per cent. This treatment is much like the preceding ones. The above process is repeated two times more. These three acid alcohol extracts contain the active material. They are evaporated in shallow dishes at low temperature with the aid of a fan. The residue is dissolved in a small volume of acid alcohol and precipitated with acetone and ether. The solution and precipitation is repeated. It is further purified by solution in water containing enough pyridin to dissolve the material and then precipitated with acetone and ether. The yield is very satisfactory.

The use of acetic acid in the above extracting medium is the least objectionable, though the other acids in low concentration are also very effective. In place of methyl alcohol, ethyl or propyl can be used. Sixty per cent. acetone and acetic acid is also a very satisfactory solvent.

The final product is not very soluble in distilled water, though moderately soluble in boiled distilled water. It has a rather sharp iso-electric point at about pH 5. It easily dissolves in dilute acids or dilute alkalies. It is precipitated by copper and zinc salts, by many of the acid protein precipitants and by salting out with ammonium chloride and other salts. The biuret is pale violet. Trypsin, as well as strong acids, destroy the activity and hydrolyze the substance. It is unstable in weak alkali. It seems to be a polypeptide. It contains labile sulfur. It gives strong reaction on blood vessels and isolated uterus, but has no effect on frogs' melanofores.

C. G. MACARTHUR
UNIVERSITY OF BUFFALO

THE OCCURRENCE OF FILTERABLE FORMS OF BACTERIA IN NATURE

FOR a number of years many bacteriologists have refused to follow the conventional view that the bacteria are limited in their morphology to the typical cells with which we are familiar in the laboratory. Increasing evidence of pleomorphism and life cycles, which may include ultramicroscopic and filterable forms, has accumulated. Throughout the world the number of workers capitulating to the more "radical" school of bacteriologists has increased during recent years. In America, among others, have been such outstanding investigators as Drs. Mellon, Löhnis, Henrici, Rosenow, Hadley and Alice Evans, who have vigorously supported the newer view in one or more of its several aspects.

To Hadley and his coworkers belongs the honor of having proved beyond reasonable doubt the existence of filterable forms of several of the well-known bacteria. A careful reading of the work of Hadley, Delves and Klimek[1] should be sufficient to convince fair-minded skeptics.

While knowledge of "filterable viruses" as the causes of certain diseases is old, our knowledge of such organisms has been limited to a few obligate parasites. That there exist free-living saprophytes of such a nature has been denied. Thus Barthel and Bengtsson,[2] in a work addressed specifically to this problem, found no evidence of filterable microorganisms in soil. From the work of Hadley and his asso-

[1] *J. Infect. Diseases*, 48, 1–153, 1931.

[2] Meddelande No. 341, Centralanstalten försöks. jordbruk., Bakteriologiska avdelningen No. 47 (1928).

ciates it would seem not only logical but inevitable that bacteria in all stages of their developmental cycles should be found in nature. It is of value to demonstrate this fact because of its many important implications, biological and practical. It is important, also, in order to remove the many significant observations of Hadley and previous investigators from the shallow objection of being artificially induced laboratory "involutions."

Following the methods of Hadley, and also with slight variations therefrom, we have demonstrated the presence of filterable microorganisms in soils, decomposing manure, hay infusions, fresh human feces and milk. We have followed the transformation of some of the "g" types (Hadley) to the point where they would be recognized as "bacteria" in the usual sense. It should hardly be necessary to state that all filtrates have been controlled and tested for "sterility" by the conventional methods. Berkefeld v and n filters have been used with the same positive results. Growths obtained from the filtrates have been refiltered and the "g" types again developed.

James M. Sherman
Clair E. Safford

Cornell University

POSITIVE GAS AND WATER PRESSURE IN OAKS

Evidence of positive gas and water pressure in forest trees was observed by the writers during the late summer and early fall of 1930, in western North Carolina and northern Georgia hardwood forests.

In connection with a growth study carried on by the Appalachian Forest Experiment Station, numerous forest trees were drilled with the increment borer. This tool consists of a hollow steel bit, turned like an auger into the bole of a tree (usually at breast height). The hollow bit will then extract a solid core of wood somewhat smaller in diameter than a pencil, extending from bark to pith. A sudden reverse twist of the handle frees the core from solid wood at the inner end of the bit. Annual rings on the core can be counted for determining age or measuring growth along that particular radius.

It was the writers' observation that frequently after the bit had been inserted two inches or more, scarlet oaks (*Quercus coccinea*) would emit enough liquid to cause a dripping from the outer end of the borer. Often there was an accompanying hissing sound as though gas were escaping, though not with any great pressure.

One 14-inch apparently sound scarlet oak was encountered which had sap pressure enough to eject the 3-inch core with considerable force and follow it with a stream of liquid which was thrown 3 to 4 feet from the base of the tree. This liquid had the characteristic ill-smelling odor of scarlet oak sap. The occurrence seems more remarkable considering the very dry season preceding it. At that time, late summer, the rainfall deficiency for the calendar year was 12.73 inches related to a normal of 40.28 inches.

The only two species in which inflammable gas was found were the chestnut oak (*Quercus montana*) and the white oak (*Quercus alba*). In some of these trees, which ranged from 8 to 16 inches, diameter breast high, the positive gas pressure was sufficient to blow the core out of the hollow bit with considerable force. The gas was frequently lighted and would shoot a blue flame, sometimes 1½ to 2½ feet long, extending horizontally near the source but gradually curving upward to its tip. The flame would burn steadily for thirty seconds or so, then gradually lose force and become smaller. It was usually snuffed out soon after lighting to preserve the temper of the borer. In all trees issuing inflammable gas the heartwood was unsound, apparently affected by a dry rot. Curiously enough failing pressure could occasionally be revived by turning the borer into the tree a little farther; sometimes the issuance of gas was stopped completely by turning it too far. Because of the fact that the flame was blue it suggested a gas similar to, if not, methane, which is known to be a product in the decomposition of cellulose.

The writers have not observed positive gas or sap pressure in any other species or at any other season of the year than indicated above. Wood,[1] however, observed inflammable gas in white oak and red oak (*Quercus borealis*) in West Virginia during the fall of 1927. Such phenomena as have been observed may be of interest to investigators of the water and gas systems of trees.

C. A. Abell
C. R. Hursh

Appalachian Forest Experiment Station,
Asheville, North Carolina

ANALYSES OF THE BLOOD OF IDIOTS

In the issue of Science for March 20, page 316, there appears a note headed "Biochemistry in Relation to Intelligence." In this note the writer, H. D. Powers, claims to have found an abnormal amount of inorganic phosphate in the blood plasma of idiots. In results which we have obtained from analyses of blood samples taken from idiots of classified mentality we have been unable to obtain such results. Inorganic phosphorus in blood plasma samples from twenty-five idiots has been found to be within the normal limits. Our results range from 3.1 mgs to 5.0 mgs per 100 cc of blood, with an average of 4.0

[1] L. M. Wood, "Gas from Trees," Service Bulletin, U. S. Forest Service, Washington, D. C. December 1, 1930.

mgs per 100 cc. The ages of the idiots range between eleven and forty-four. Obviously diet was carefully considered. Acid soluble phosphates, lecithin, percentage hemoglobin, red cell count and cell volume have been found to be within the normal limits also. Our results indicate that there is some variation from the normal in the cholesterol content.

SIDNEY S. NEGUS

MEDICAL COLLEGE OF VIRGINIA,
RICHMOND, VIRGINIA

DRAWINGS FROM PHOTOGRAPHS

To Professor Naylor's method, given in SCIENCE of January 2, 1931, for making drawings from photographs, we wish to add two suggestions which greatly increased the efficiency of this method for us: First, use grade A No. 2 Carbon Azo or other make of equal grade; and second, slightly overexpose and underdevelop the print which is to be inked in.

G. E. MACGINITIE

HOPKINS MARINE STATION

QUOTATIONS

INDUSTRY AND SCIENTIFIC RESEARCH

ALTHOUGH many of the branches of organic chemical industry have sprung from the discoveries, often fortuitous, made in scientific laboratories—as, for example, Perkin's mauve, Griess's azo dyes, Baeyer's phthaleins and synthetic indigo, Knorr's antipyrine, Ehrlich's salvarsan, the nitrocellulose silk of Count Chardonnet, the viscose of Cross—the significance of such discoveries was frequently unrealized at the time either by scientific workers or industry. This alone should make us cautious in advocating any restriction of research. There are too many problems in our national and industrial life urgently demanding scientific solutions for such a policy to be either timely or wise. It is almost impossible to predict just where the next important advance will be made, or, in reviewing the results of a year's investigations, to single out the one discovery by which posterity will mark the year.

The influence of industry on scientific research is, however, fully as important as that of scientific research on industry. Even in the field of technique it is impossible to assess the contributions of either on a cash basis. The greater resources of the industrial research laboratory and its improved and frequently more advanced technique are continually reacting on scientific laboratories. The range of reaction conditions open to the organic chemist has enormously expanded in the last decade, and processes can now be effected in extremely high vacuum or under pressures of several thousand atmospheres and at temperatures ranging from the neighborhood of absolute zero to those of the electric furnace; whilst the activators or catalysts available range from the new organic catalysts, bordering on biochemistry, over almost the whole field of inorganic chemistry.

Nor is it only refinements of technique that are continually changing the conditions of scientific and industrial research. Almost every year sees fresh compounds, formerly curiosities and accessible only by tedious and costly laboratory processes, produced on the commercial scale at a price which allows their use in industry or in scientific laboratories as the raw material of further researches. The papers published in the journal of any chemical society reveal the way in which the scope of scientific research has been enlarged and influenced by industrial advances. The utilization of waste materials, the delicate balance between by-product and main-product, the fall or rise in price of basic materials like sulphuric acid, methyl alcohol, glycerol, which alone may result in new routes for existing products—the war-time shortage of sulphuric acid, for example, led to the development of alternative processes for phenols and amines which have not been entirely replaced by the earlier methods—these are factors which continually emphasize the dynamic character of industrial research and frequently have far-reaching effects on scientific research.

If, however, the increasing complexity of the field of organic chemistry makes restriction of research inconceivable, the demands made on leadership are increasingly severe. It was never easier than to-day for research ability to be wasted in an attack on unprofitable problems. Scientific progress has almost invariably come from the ideas and work of a talented few, and depends as much upon the quality and personality of the investigator as upon his technique. The most serious problem is the production of research leaders of the requisite imagination, foresight and enthusiasm to direct wisely the team work which modern industrial research demands. Any circumstance, whether of rates of pay, status, or insecurity of tenure which hinders the recruitment for industrial research of potential leaders of the requisite calibre is a national and not merely an industrial danger. There is little doubt that if the concentration of professional opportunities within at most one or two firms, as in Germany, does affect adversely the position and prospects of chemists, industry will quickly suffer from the reaction.

The distinction between scientific and industrial research to-day is not easy to define. Their relationship is dynamic and so intimate that circumstances which

injure or cramp one react likewise on the other: neither can advance while the other is starved, and on this fact Professor Willstätter based his plea for more generous assistance for the German universities from chemical industry. Such assistance is now being given more freely in Great Britain, and the closer relationship between the universities and industry are undoubtedly to their common advantage.

It is easy, however, to overstress from either side the economic aspects of the relation between industry and scientific research. If there are ways in which scientific research can not compete with industry, there are still inestimable services which scientific research can render to the nation as well as to industry. Scientific research, in its freedom from the economic motive, can do much to counteract that tendency in industry for the good to be the enemy of the best, and to secure our advance to the best of all possible solutions. Scientific research, in the widening fields opened to it by industrial developments, can use its resources to explore the byways, the economically unattractive fields from which will come in the future, as they have so often in the past, the fundamental and epoch-making discoveries. On such workers, too, in their quest of truth for truth's sake, must ever fall the responsibility of kindling and rekindling that enthusiasm and devotion to which alone nature yields her most precious secrets.—*Nature*.

SOCIETIES AND ACADEMIES

ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The annual meeting of the Ohio Academy of Science this year took the form of a joint meeting of the Ohio, Indiana and Kentucky Academies of Science and was held at Miami University, at Oxford, Ohio, on April 2, 3 and 4. The meeting was sponsored by the Sigma Xi Club of Miami University, which conceived the idea of inviting these three academies to visit Oxford, which is admirably situated about equidistant from the capitals of the three states. About four hundred members of the combined academies were present and a very pleasant and profitable meeting was held. Miami University, with her admirable dormitory system and commissary department, was able to handle the guests very comfortably and in a homelike manner.

On Thursday afternoon a field trip was planned and conducted into the Cincinnati area by Dr. William H. Shideler to study pre-glacial and post-glacial stream valleys. Inclement weather somewhat interfered with plans for collecting, but an interested group was in attendance. The same evening an illustrated lecture on "Traces of Early Man in Western Europe" was given by Professor F. O. Grover, of Oberlin College, followed by a social hour.

The program on Friday morning, April 3, opened with three addresses by the presidents of each of the academies. President August Foerste, of the Ohio Academy, spoke on "Ancient Life in the Arctic." President J. J. Davis, of the Indiana Academy, gave an interesting talk on "Points of Historical and Natural Interest in Indiana." This was followed by a talk by President V. F. Payne, of the Kentucky Academy, on "An Optimistic View of the Evolution of Science." The talks of the presidents were followed by a motion picture of "The Colorado from the Air," given by Professor A. A. L. Mathews, of Oberlin College. Many demonstrations and exhibits attracted the attention of the members for the rest of the morning as well as during the course of the meetings.

The presentation of papers occupied Friday afternoon and Saturday morning. Six sections presented 124 papers, distributed as follows: Zoology 21, botany 19, geology 27, medicine 14, psychology 15 and physical science 23. The Akron Physics Club and the Central Physics Club met with the physical science section.

Business sessions were held by the Ohio Academy as well as by the Indiana Academy. Seventy-one new members were elected.

The following officers were elected for the coming year:

President, Alpheus W. Smith, Ohio State University.

Vice-presidents, J. Paul Visscher, Western Reserve University, *Zoology;* Arthur T. Evans, Miami University, *Botany;* E. M. Spieker, Ohio State University, *Geology;* Shiro Tashiro, University of Cincinnati, *Medical Science;* H. B. English, Antioch College, *Psychology;* F. G. Tucker, Oberlin College, *Physical Science.*

Secretary, Wm. H. Alexander, Weather Bureau, Columbus.

Treasurer, A. E. Waller, Ohio State University, Columbus.

On Friday evening a banquet was served to more than three hundred members of the participating academies. An address of welcome by President A. H. Upham, of Miami University, was responded to by the presidents of each of the academies as well as the presidents of the attending physics clubs.

Dr. Arthur T. Evans was chairman of the social committee on arrangements.

Wm. H. Alexander, *Secretary*
Weather Bureau, Columbus

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ADJUSTABLE DOUBLE-SLIT

Certain experiments in diffraction and interference require a double-slit in which the distance between two slits may be varied while the slits remain parallel to each other and the space between them is kept closed. It is this last requirement which is, of course, the difficult one to meet.

In preparing a 4-inch telescope to illustrate Michelson's interference method for measuring stellar angular diameters it was found desirable to have an adjustable double-slit which would satisfy the above requirements. The method devised for accomplishing the desired results is quite simple and efficient.

The apparatus consists of two brass plates A and B which are placed in contact as shown in the figure.

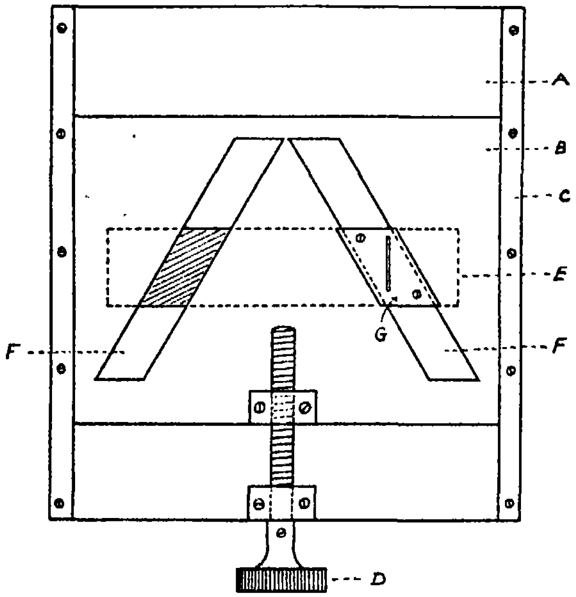


Plate B is kept in place by the guides C, and it may be moved over A by means of the screw D.

A rectangular opening E is cut in plate A, and two openings F are cut in plate B. The latter openings make an angle of 60 degrees with each other in the present case. With such openings in A and B it is apparent that two parallelogram shaped holes will extend through both plates. The cross-hatched area at the left side of the figure indicates one of these holes, and the other is at the place marked G. It follows that these holes may be moved close together or far apart by turning the screw D which slides plate B over plate A. It is in these holes that the blocks containing the slits are placed.

G shows one of the slit-blocks in more detail. The slit-blocks consist of three parts. One is a parallelogram shaped piece of brass made just the size of the holes through the two plates. This piece has a thickness equal to that of both plates A and B. To each side of this piece is screwed a thinner brass plate which has the same parallelogram shape but which is slightly larger than the first. The overlapping portions of these plates form flanges which hold the center piece in place. The overlapping of the thin front plate over B is shown in G. A similar overlapping occurs on the back side of A. Apertures of the desired size and shape may be cut in these slit-blocks.

Since the slit-blocks extend through both plates A and B, the wedge action of the openings F in B is able to cause only a lateral motion of the slit-blocks. At the same time the space between the slit is kept closed since the remainder of plate B is solid.

If the plates and blocks are carefully fitted, the slits will remain quite parallel to each other, and no trouble will arise from binding of the parts. In the apparatus described the slits may be moved from 1 inch to 4 inches apart.

R. William Shaw

Department of Physics,
Cornell University

A FUSED QUARTZ FÉRY PRISM

The following apparatus was constructed to test the possibilities of a fused quartz Féry prism for ultra-violet spectrographic work. A light-tight box was constructed as indicated in Fig. 1, with the quartz condensing lens and the quartz prism the only optical parts. The prism, which was cast by the Thermal Syndicate of Brooklyn, N. Y., has a front surface of 28 inches in radius, and makes an angle of 30°

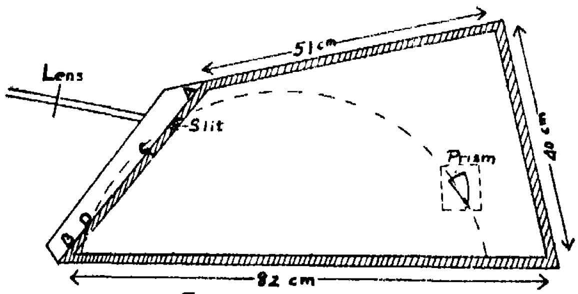


Fig. 1

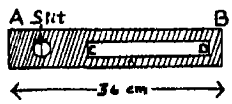


Fig. 2

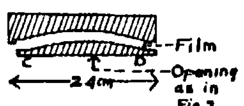


Fig. 3

with a rear surface, silvered, of 27 inches radius. The spectrum, slit and prism lie on an arc of a circle of 28 inches diameter. The spectrum can be thrown on a screen or photographed (*DC*, Fig. 1). The dispersion increases with decreasing wave-length, and from the red to 2,000 Å gives about a 10-cm spectrum. Eastman portrait film cut 3 cm wide and held against a curved wooden support (Fig. 3) was used satisfactorily for the photographic work, with a metal slide to prevent fogging. The prism is loosely held in a simple frame. Rough adjustments of aligning and focussing can be made quite quickly as the prism is the only movable part.

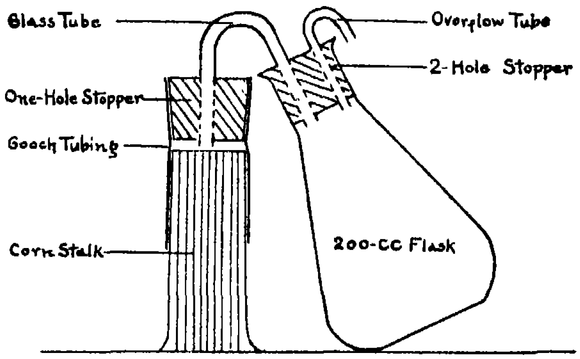
The apparatus was designed and practically completed by Dr. John F. Mohler in the physics laboratory of Dickinson College, in an attempt to find an inexpensive piece of apparatus for student work in the ultra-violet. There is no record of the exact cost, but it was certainly less than fifty dollars.

Nora M. Mohler

Smith College

SAP FOR ANALYSIS BY BLEEDING CORN PLANTS

During the past three summers at Athens, Georgia, clear sap has been secured by bleeding corn plants on various fertilizer plats. The bleeding has been done by cutting the stalk just below one of the nodes near the surface of the soil and attaching a flask to the stump. A single plant about the silking stage and under favorable conditions will bleed more than 500 cc in a three-day period. This sap contains much less organic and inorganic material than expressed sap which is being studied in connection with soil fertility experiments at several experiment stations. The analyses made of the bled sap to date indicate that it is much nearer the composition of the displaced soil solution than is expressed sap. The ease of securing sap by bleeding, its similarity to the displaced soil solution, and its favorable condition for analysis with a minimum of corrective treatments are distinct advantages in a method for studying plant-soil relations by sap analysis. Doubtless the method can be used with many agricultural plants.



A beginning was made in the use of this method of securing sap for analysis by bleeding plants in 1864.[1] Ulrich bled potato plants for five consecutive days and analyzed each day's run for dry weight, ash and combustible material.

It has been found necessary to remove tillers and green leaves of the corn plant below the point where the stalk is cut if a good flow of sap is to be secured. Removal of these several days before cutting is preferable. There should be a perfect fit between the stalk and the rubber tube to prevent leaking. A few drops of formalin have been used in each flask to prevent fermentation of the sap. Where extended bleeding has been carried on, it has been necessary to make fresh cuts on the stalk every three or four days to renew the bleeding face. Under very favorable conditions, stalks have been bled for fifteen consecutive days and in this time the most vigorous have yielded slightly more than 1,700 cc of sap each.

M. W. Lowry
Paul Tabor

Georgia State College of Agriculture,
Athens, Georgia

SPECIAL ARTICLES

HUMIDITY AND COMFORT

Experiments reported by the New York State Commission on Ventilation (1922) indicate that a variation of 30 per cent. in relative humidity (20 to 50 per cent.) at a room temperature of 75° F. does not exert any very distinct influence upon the sense of comfort, after an exposure of as much as three and a half hours. Later work by Miura carried out with care upon a few subjects showed that at 70° F. an increase of 50 per cent. in relative humidity (20 to 70 per cent.) was accompanied by a small but distinct increase in the subjective sense of warmth, although at a lower room temperature (61° to 62° F.) a change in humidity of this magnitude had no perceptible effect. In his effective temperature chart, Yaglou has given a graphic representation of this influence of humidity upon the sense of comfort.

Since the question frequently arises as to whether or not it is desirable to humidify the air of lecture rooms, a series of observations in regard to this point

[1] Palladin-Livingston, "Plant Physiology," 3rd ed, p. 142.

was made upon one of the classes in the School of Hygiene and Public Health of the Johns Hopkins University during the session of 1930–1931. The results are of sufficient interest to warrant a brief report. The class met once weekly for an hour during the fall and winter months. The attendance at each lecture varied between 40 and 45 persons and the personnel changed slightly during the observations, owing to some withdrawals and new admissions at the end of the first trimester. The class contained some 8 to 10 women and a number of nationalities were represented. About one half were foreign students in attendance at the school, representing the following countries: India, Malay Peninsula, China, Japan, Siam, Mexico, France, Italy, Greece, Poland, Bulgaria, Roumania and Czechoslovakia.

The lecture room has a capacity of 16,000 cu. ft. with a height of 13½ ft. A large duct connects the room with an adjoining air conditioning plant by means of which the temperature, humidity and air-movement may be controlled. The incoming air is brought into the room through a wide duct, with lateral openings, running along the ceiling, and air is sucked out through gratings in the walls near the floor level. In all of the observations the supply fan was run at one-half speed, delivering 1,500 cu. ft. per minute, and the exhaust fan at full speed, with an estimated capacity of 3,000 cu. ft. per minute. This combination was selected because it was found experimentally that it gave, in connection with a suitable control of the lateral openings of the delivery duct, the most uniform distribution of air currents throughout the room, when occupied by a class. The air in the room was renewed approximately ten times during the course of the hour.

The object of the observations was to keep the room at a temperature of 70° F. and to vary the humidity on different days. Readings were taken, at the beginning and end of the hour, of the dry bulb and wet bulb thermometers, the dry kata and the temperature of the incoming and exhaust air. Readings were made also for the temperature and humidity of the outside air. The readings in the room were taken from an elevated platform at the rear center of the room. At the beginning of the hour the students were given a printed slip upon which they recorded their sensations of comfort during the hour in accordance with the following classification:

1. Too cold—(uncomfortably cold).
2. Comfortably cool.
3. Comfortable.
4. Comfortably warm.
5. Too warm—(uncomfortably warm).

In three experiments the room temperature rose to 71.5°–73° F. and for this reason they were not used in summarizing the results. One additional experiment was rejected because a cold north-west wind was blowing upon the northern exposure of the room and the leakage through the windows set up cold drafts of air on that side of the room. In the balance of the experiments the room temperature was kept uniformly at 70° F. throughout the hour in 13 cases. On one day the temperature was 69° F. and on another occasion it rose to 71° F. The maximum variation, therefore, in the observations that were compared was 1° F. on each side of the 70° line. In six of the observations the relative humidity was kept between 55 and 60 per cent., once at 48 per cent., twice at 33 to 40 per cent., twice at 20 to 30 per cent.,

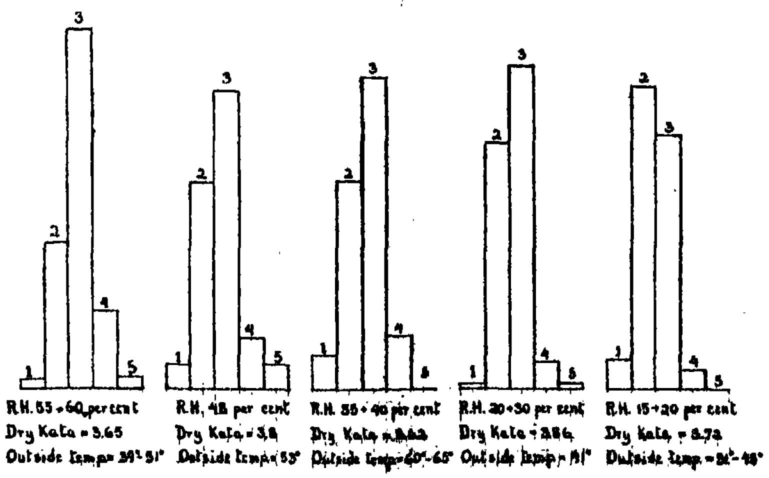


FIG. 1. Graph showing the comfort vote of a group of 40 to 45 persons for a dry bulb temperature of 70° F. (69°–71°) with varying degrees of relative humidity. The ordinates indicate the percentage of the total attendance voting for each specified degree of comfort, according to the classification, 1—Too cold; 2—Comfortably cool; 3—Comfortable; 4—Comfortably warm; 5—Too warm.

and four times at 15 to 20 per cent. The dry kata reading varied on these different days between 3.62 and 3.86. In spite of the active ventilation the kata reading was low throughout. Experience has shown that a reading of 6, designated as optimum for Great Britain, is too high for class-room conditions in this country.

A summary of the results of these fifteen observations is given in Table 1 and Fig. 1. The figures and graphs represent not the actual number of individuals voting for the different grades of comfort, but the percentage of the total attendance for each day that so voted.

TABLE 1

Dry Bulb Temperature in Room, 69° to 71° F. Dry Kata 3.62 to 3.86

Comfort report	Relative humidity 55 to 60 per cent.	Relative humidity 48 per cent.	Relative humidity 35 to 40 per cent.	Relative humidity 20 to 30 per cent.	Relative humidity 15 to 20 per cent.
Too cold (1)	1.7	4.2	5.6	1	5.1
Comfortably cool (2)	24.3	34.0	34.25	40.4	49.55
Comfortable (3)	59.3	49.0	51.3	53.0	41.7
Comfortably warm (4)	12.6	8.5	8.8	4.45	3.4
Too warm (5)	2.1	4.2	0	1.0	0

1. The record shows that in the experiments as a whole from 91 to 97 per cent. of the group found 70° F. comfortable, irrespective of the humidity. That is to say, they reported that the conditions were either comfortable, comfortably cool or comfortably warm. Much the larger portion, 83 to 93 per cent. made a selection between comfortable and comfortably cool. The composition of the group who voted 3, comfortable, on the different days varied considerably. For example, in the six experiments in which the physical conditions were kept constant at a dry bulb of 70° F. and a relative humidity of 55 to 60 per cent. only four voted "comfortable" consistently for the six days. The others on one or more occasions reported themselves as comfortably cool or comfortably warm.

2. It will be noted that as the humidity decreased the size of the group voting 2, comfortably cool, increased from 24 per cent. at humidity 55 to 60 to 49 per cent. at humidity 15 to 20, giving an indication of the cooling effect of the drier air when the dry bulb remains constant. On the other hand group 4, comfortably warm, shows an increase from 3.4 per cent. to 12.6 per cent. as the humidity increases.

3. The small groups who found the conditions too warm or too cold were composed for the most part of the same individuals. There were two or three in the class for whom 70° F. at any humidity was uncomfortably cool, and a few others for whom the same conditions were at times uncomfortably warm.

4. While the optimum humidity seemed to be 55 to 60 per cent. it may be concluded that in an auditorium kept at the standard temperature of 70° F. variations in humidity between the limits used, which are those that ordinarily prevail indoors in temperate climates under winter conditions, make but little difference in the sense of comfort and well being of the occupants. It is doubtful, therefore, whether there is any justification for the installation of expensive equipment for the control of humidity. For such conditions the dry bulb temperature is the important standard to maintain, together with provision for the renewal and adequate movement of the air.

W. H. Howell

The Johns Hopkins University

MODIFICATION OF THERAPEUTIC SERA WITH A VIEW OF AVOIDING COMPLICATIONS OF ALLERGIC NATURE[1]

Therapeutic as well as prophylactic administration of various sera derived from immunized animals has proved of such great value that it is resorted to in a constantly increasing number of instances. However, a certain not insignificant hesitancy still exists among the practicing physicians due to the fact that occasionally parenteral introduction of therapeutic sera has been known to be accompanied by grave complications and even by the death of the recipient.

While Park[2] estimates that only one out of 20,000 of those receiving serum for the first time develops alarming symptoms and only 1 in 50,000 succumbs as a direct result of the treatment, one can readily understand the hesitancy of a physician who goes through the experience of losing his patient in spite of his taking all known precautions to ward off this calamity.

In this paper we are suggesting a procedure which promises to minimize if not eliminate entirely the risk involved in the practice of serum therapy.

With respect to possible response to parenteral introduction of therapeutic sera, the human race can be divided into four categories.

(1) A significant portion (about 10 per cent.) show no visible response whatever to injection of serum.

[1] Presented before the joint meeting of American Association of Pathologists and Bacteriologists and American Association of Immunologists at Cleveland, April 1–3, 1931. This investigation has been aided by a grant from Eli Lilly and Company.

[2] W. H. Park, *Am. J. Pub. Health*, 18, 354, 1928.

(2) The bulk of recipients of serum is composed of normal "individuals" who present more or less marked symptoms of the so-called "serum sickness," appearing usually within seven to twelve days after the parenteral introduction of therapeutic serum.

(3) A small number (a fraction of 1 per cent.) of individuals are so-called "naturally hypersensitive" to horse protein. These individuals have no knowledge of any previous exposure to parenteral introduction of horse protein, but they respond to injection of horse serum by an immediate violent reaction leading to collapse and sometimes death. The incidence of this sort of reaction is estimated to be about 1 in 20,000[2] of all those treated.

(4) Quite a large group of recipients of serum therapy is composed of individuals who originally belonged to the group of normally reacting individuals (group 2 above), but who, as a result of receiving parenteral injection of horse serum some time in the past, have become artificially sensitized to it and henceforth usually react to subsequent introduction of serum by developing "serum sickness" after a foreshortened (sometimes as short as three hours) period of incubation. A certain number of individuals in this group, however, may respond to injection by immediate acute symptoms entirely analogous to individuals in the group 3 above.

Due to continuous extensive use of therapeutic sera in connection with a variety of diseases this group is constantly on the increase. Moreover, the use of prophylactic immunization with toxin-antitoxin mixture further contributes to rapid increase of those artificially sensitized to horse protein.[3]

While the use of purified antibody preparations tends to diminish the frequency and the extent of sensitization, according to some investigators,[2] according to others[4] globulin fraction is an exquisite sensitizing antigen. Even the extremely small amounts of globulin introduced by the toxin-antitoxin immunization is sufficient not only to establish skin sensitization in a not inconsiderable percentage of cases,[5] but also in some instances injection of toxin-antitoxin seems capable of engendering a high degree of general hypersensitiveness resulting in severe symptoms following subsequent introduction of serum.[6]

In practice the frequency of complications incident to serum therapy is reduced somewhat by desensitization. However, while this procedure seems to be quite efficient when applied to animals, its efficiency in man is considerably less certain. In some cases a fair degree of tolerance to serum can be established after careful and prolonged desensitization. In other cases, particularly in individuals known to suffer from asthma or hay fever, desensitization is extremely dangerous if not impossible, because administration of even minute amounts of horse serum may be followed by grave symptoms or even death.[7]

The only procedure theoretically available for safe serum therapy of such individuals consists in employment of therapeutic sera derived from such animals to the protein of which the recipients show no hypersensitiveness. In practice this procedure usually can not be carried out because therapeutic sera are prepared in horses almost exclusively.

It is evident that if the protein of the therapeutic serum could be deprived of its species specificity the difficulty might be overcome.

The possibility of accomplishing this end was suggested by the early work of Obermeyer and Pick[8] and of Landsteiner,[9] who succeeded in destroying the species specificity of proteins and imparting to them a new chemical specificity by subjecting them to appropriate chemical treatment. Since these experiments were made only for the purpose of eliciting the relation between the antigenic specificity and chemical structure, the authors were not concerned with the extent of changes which protein underwent during this treatment. When the methods used by them were applied by us in the attempts to destroy the species specificity of therapeutic sera, it was soon found that their methods were too drastic. While sera usually lost their species specificity as a result of chemical coupling, the therapeutic properties of the sera were lost at the same time.

Fortunately by a proper modification of procedures, particularly with the view of avoiding extreme changes in temperature, hydrogen-ion concentration and rapid oxidation, we have succeeded in obtaining several compounds which seem to possess the desired properties.[10]

(1) Out of many procedures tried so far, in general coupling with diazotized aromatic amines has given the most promising results. Among the com-

[3] In this connection, Park's suggestion of using goats as donors of serum for the preparation of toxin-antitoxin mixture is an important step in the right direction.

[4] H. H. Dale and P. Hartley, *Biochem. J.*, 10, 408, 1916.

[5] S. B. Hooker, *J. Immun.*, 9, 7, 1924.

[6] J. E. Gordon and S. M. Criswell, *J. Prev. Med.*, 3, 21, 1929.

[7] R. W. Lamson, *J. Am. Med. Assn.*, 93, 1775, 1929; also *ibid.*, 82, 1091, 1924; R. A. Cooke, *J. Immun.*, 7, 119; 1922; J. G. M. Bullowa and M. Jacobi, *J. Am. Med. Assn.*, 46, 306, 1930.

[8] F. Obermeier and E. P. Pick, *Wien Klin. Woch.*, 19, 327, 1906.

[9] K. Landsteiner, *Biochem. Zeitschr.*, 58, 362, 1913; K. Landsteiner and H. Lampl, *Biochem. Zeitschr.*, 86, 343, 1918.

[10] J. Bronfenbrenner, Proc. Soc. Exp. Biol. and Med., 27, 734, 1930; similar observations were reported also by L. Reiner, SCIENCE, 72, 483, 1930.

pounds prepared, good results were obtained by coupling immune sera with diazonium salts of para-toluidin, para-anisidine, atoxyl, sulphanilic acid, anthranilic acid, naphthionic acid and amino R salt.

(2) The preparations obtained have lost their species specificity. They were not precipitated by the potent anti-horse precipitating serum. They did not cause anaphylaxis when injected intravenously into guinea-pigs highly sensitized to horse serum nor did the injection of these compounds protect the animals against subsequent death from injection of unmodified horse serum. They did not cause skin reactions in horse-asthmatics.

(3) Several of the preparations secured by the different couplings were found to be mutually heterologous—that is to say, they did not sensitize guinea-pigs to each other.

(4) Antigenic properties of these preparations were found to be in general less marked than those of native serum and thus there is a possibility that their use may not be followed by serum sickness in as large a percentage of cases as is usual with unmodified horse serum.

(5) While these serum preparations have thus completely lost their species specificity as result of coupling, they retained nevertheless to a fair degree their specific immune properties. Though in general the antibody content of these preparations was found to be lower than that of the original sera from which they were prepared, we hope that by further improvement of the chemical procedures the antibody content of the final product may be sufficiently increased to make this procedure practical.

(6) In so far as experiments on mice and guinea pigs have thus far indicated, these preparations are not toxic. Only when given intracardially in the amounts roughly approaching (weight for weight) the therapeutic doses in man have we seen any evidence of untoward symptoms. But even in the most marked cases these symptoms lasted only for a few minutes following the injection and in general suggested that they may have been caused by the rapidity of injection alone.

J. BRONFENBRENNER
D. M. HETLER
I. O. EAGLE
WASHINGTON UNIVERSITY MEDICAL SCHOOL,
ST. LOUIS

A POSSIBLE RELATIONSHIP BETWEEN HEMOGLOBIN AND CHLOROPHYLL AS SHOWN BY THE USE OF LIVER EXTRACT

THAT there is a striking chemical similarity between chlorophyll, the characteristic green pigment of plants, and hemoglobin, the red-colored material of the blood of animals, has been called to the attention of biochemists since the early part of the century. Treatment of both materials with an acid and then an alkali results in the respective porphyrins—phylloporphyrin and hematoporphyrin—differing only slightly in the amount of oxygen contained. Furthermore from both of these substances can be obtained (Nentski and Marchlewski, 1901) the same substance, hemopyrrol.

In addition to these similarities in chemical analysis, it is not unreasonable to expect physiological resemblances. Both are pigments, and, according to Palladin, both are instrumental in the transfer of oxygen. This is the recognized function of hemoglobin, and Willstätter and others have assigned a somewhat similar function to chlorophyll in the photosynthetic process. Manoilov more recently (1922) produced evidence that the chemical tests which distinguish male from female blood are equally applicable to male and female chlorophyll in dioecious plants.

With these as precedents it was thought of possible interest to see if the same substances which influence the formation of hemoglobin in the blood would have any effect upon the formation of chlorophyll in plants. For this purpose liver extract was selected because of its interest in the study of pernicious anemia. Liver extract is a specific for pernicious anemia, but its method of action is still a disputed point. Does it check the disease by preventing the destruction of the hemoglobin, by aiding in its formation, or both? Also is the effect upon the pigment or upon the stroma of the red cells? The present tendency is to favor the idea that its effect is upon the destruction of the red cells rather than upon their formation, but no good method seems to have been devised to test the precise nature of these effects.

On the assumption that liver extract might have an analogous action on chlorophyll and that from such experiments hints might be obtained as to the action of the extract on hemoglobin, corn plants (also peas, but results were not so good) were grown in clean, moist sawdust until the roots were about 2 inches long and the first leaves were well unrolled. The plants were then carefully washed and transferred to 300 cc of Knop's nutrient solution, after which they were placed in the light for three days or until they should become accustomed to the new conditions of the nutrient solution.

To the solutions containing the test plants was then added 0.5 cc of a solution of liver extract made by dissolving a tube of Lilly's commercial extract (about 4.5 gm) in 25 cc of distilled water. The plants were then transferred to a dark room and left for from

5 to 10 days. At the end of that time it was noticed that in every case the plants containing the liver extract in solution were distinctly greener than the controls without the liver extract. Some factor in the liver extract has apparently checked the destruction of the chlorophyll; this destruction of chlorophyll goes on constantly, but in the daylight the pigment is constructed as fast as it is destroyed. Whether this is the same effect as observed in the use of liver extract in cases of hemoglobin deficiency, such preliminary experiments can not decide. Purified extract or amino acid crystals from liver extract should be used instead of the crude extract. Also it should be of interest to see if the liver extract will aid in the formation of chlorophyll in seedlings completely etiolated. Miss Mary E. Reid (unpublished experiments) found that albino seedlings when fed liver extract in a similar fashion showed a greening in excess of controls.

Since laymen still like to get evidence upon the fundamental relationship of plants and animals, such experiments might be brought forward in support of the doctrine of the common origin of plants and animals, but such was not the original purpose of these rather elementary researches. On the other hand, these experiments as here reported were simply meant to be suggestive of the aid which the study of plant physiology may be able to render to the study of animal physiology on the assumption that vegetable and animal substances of a similar chemical nature and of common origin may be supposed to have a physiology at least similar if not strictly identical.

ORAN RABER

IMMACULATA COLLEGE

THE LIFE CYCLES OF TRICHOGRAMMA MINUTUM IN RELATION TO TEMPERATURE

THE egg parasite *Trichogramma minutum* is an ideal organism to use in experimental work. Practically the only limiting factor in its production is the amount of food available. Under proper conditions, however, its food can be easily provided. In the laboratory, with an abundance of food at hand, it is one of the most easily reared of any highly developed organism. It can be reared at the rate of 52 generations a year. Reared under mass production methods, the average number of progeny per female is 12 and the sex ratio is about 0.5.

The adults are sexually mature when they emerge from their host, and they mate promptly so that the sequence of generations is uninterrupted. Because of the large number used in experimental work, individual variations are easily discounted. *Trichogramma* can be reared in the eggs of the common grain moth (*Sitotroga cerealella* Olivier) for endless series of generations in tightly corked glass vials in complete darkness. The amount of food consumed by each individual is practically constant, since as a rule only one individual develops in each host egg. Host eggs can be produced in sufficient quantities so that the average size of the eggs is constant.

Temperature appears to be the predominant, if not the only, ecological factor influencing the rate of development. The frequency of life cycles, however, is also dependent on the available host material. Under field conditions the frequency of cycles would range from one week in summer to several months in winter. Differences in length of cycles and in frequency possibly would register effects not recorded by artificial methods. Rates of development of other organisms can be compared for various sets of temperature conditions directly in terms of life cycles without resorting to developmental units or the summing of temperatures, particularly since such methods have not been perfected.

To insure uniformity of data, investigators should be supplied with a race of *Trichogramma* which has the widest range in developmental temperatures, in standardized units consisting of freshly parasitized eggs in sealed glass vials under refrigeration. Each unit should contain enough individuals so that variation can be eliminated when making observations to determine the end of the life cycle.

The period of continuous development ranges from as short as 6 days to as long as 80 days. When the temperature drops below 50° F., or rises above 90° F., its development is more or less discontinuous. Each insect is so small (a half dozen can be reared in a space of 1 cu. mm) that its response to changes in temperature is immediate.

Certain races of *Trichogramma* that are indigenous to cold climates, as in northern New England, show a wide range in degree of pigmentation correlated with developmental temperatures. When the adults of one such race show dark markings on the body, they have passed through part of their life cycle at temperatures below 70° F.

S. E. FLANDERS

COLLEGE OF AGRICULTURE,
UNIVERSITY OF CALIFORNIA

BOOKS RECEIVED

ALEXANDER, FRANZ, and HUGO STAUB. *The Criminal, the Judge and the Public.* Translated from the German by Gregory Zilboorg. Pp. xx + 238. Macmillan. $2.50.

White House Conference on Child Health and Protection, 1930. Addresses and Abstracts of Committee Reports. Pp. xi + 365. Century. $2.00.

MARCUSSON, J. *Die naturlichen und kunstlichen Asphalte.* Pp. xii + 253. Illustrated. Wilhelm Engelmann, Leipzig.

SCIENCE

VOL. 73 — FRIDAY, MAY 1, 1931 — No. 1896

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SUGARS IN THE SERVICE OF CHEMISTRY[1]

By Dr. P. A. LEVENE

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

SUGARS are the most popular topic of chemical literature to-day. There must be a reason for it, and the question arises—What is it? The importance of carbohydrates in our daily life, the numerous uses made of them in our foodstuffs, in textiles, in building materials, in the many substitutes for the more costly natural products may sound like a logical answer to the question. Indeed, it may be claimed that the progress of civilization can be measured by the extent of the uses made of carbohydrates for constructive and destructive purposes. Yet the answer would be only partially correct. It would be hard to believe that men of the type of Scheele, Baeyer, Fischer and van't Hoff devoted themselves to the problems of sugar chemistry for reasons purely practical.

[1] Delivered before the Chemical Society of Washington on the occasion of the award of the Hillebrand Prize to C. S. Hudson, March 26, 1931.

Admitting even for the sake of argument that to many workers the incentive was the applied phase of sugar chemistry, the great activity in this special field of work could not pass without leaving a deep impression on chemical philosophy. Indeed, it should be an easy matter to defend the thesis that every important industrial research extended over a long period of time must furnish a contribution to chemical philosophy which by generations to come will be adjudged to be of greater moment than the practical end which by its very nature can be of temporary value only. The history of chemistry furnishes many instances supporting this thesis, but it suffices to mention the trivial practical task which suggested to Dumas the theory of substitution.

With this thought in mind it may be proper to review briefly the contributions made by sugar chemistry to chemical theory.

The evolution of every science begins with the selection and assembly of material, the description and the analysis of which will constitute that special branch of science. It begins with a purely empirical phase which may be referred to as the period of discovery. To discover and to describe individual substances, separated from a mass of other substances, was the aim of the early chemists. It was then a purely intellectual pursuit. At this period the sugars were a great help and comfort to the chemist for the reason that many natural sugars possess great crystallizing powers. Indeed, cane sugar had been known for a long time in the Orient and was introduced to Europe by Alexander the Great. Milk sugar was crystallized in 1615 by an Italian chemist, Bartaletti, and in 1660 grape sugar was crystallized by Glauber. The important achievement of this period of chemical history was the announcement by the Russian chemist Lowitz in 1793 of the principle of crystallization as a method of purification. Another important achievement of the same period was the introduction of the microscope as a chemical instrument. The occasion for this was the analysis of beets for cane sugar. The incident led to the beet-sugar industry.

The period of discovery of natural substances was followed in the evolution of our science by the one that may be termed the period of discovery of derived substances. In this period the source of discovery was not a complex mixture of natural substances but a mixture derived artificially from a single natural substance. Again the chemist found in sugars suitable medium for these exploits for among the many decomposition products of sugars, some crystallized readily. Such substances were oxalic acid discovered by Bergmann and by Scheele, saccharic and mucic acids discovered by Scheele and many others. This purely intellectual pursuit then led to the discovery of substances which played an important part later when problems of structure came to the front.

As a rational and truly scientific discipline organic chemistry was recognized with the formulation of the ideas of chemical structure or of molecular architecture. To-day it is impossible to conceive of the term "chemical structure" without including in it that of "isomerism." Yet the idea that substances of the same composition might possess different properties was unacceptable even to Berzelius. But gradually the idea gained ground, being sponsored by the authority of Gay-Lussac, who called attention to the fact that sugar, gum and starch had similar compositions and different properties which, he maintained, were attributable to differences in the arrangements of the atoms in the individual components. True, the evidence of Gay-Lussac was not as good as his idea, but one must bear in mind that the concept "polymerism" was not yet known and that the analytical methods of Gay-Lussac were the best available. However, if it be permitted to classify tartaric acids among the sugar derivatives, then to sugar derivatives will belong the credit first for having suggested the idea of isomerism and second, for having brought about its general recognition. Indeed, it was after the discovery of mesotartaric acid by Gmelin that Berzelius withdrew his opposition to the idea that substances of identical composition might possess different properties, and indeed it was Berzelius who introduced the term "isomerism."

The term "polymerization" had a still longer struggle for recognition. But no sooner was it recognized than it was realized that simple sugars may be regarded as polymers of formaldehyde, and the Russian chemist Butlerow proceeded to demonstrate the truth of the assumption by condensing formaldehyde to a sugar. It must be added that the term "polymerization" even to-day embraces many diverse phenomena of which only some justly belong under that heading while others may be separated under the heading "condensation." The classification of these concepts and the unraveling of the nature of the forces which are responsible for the process of polymerization are some of the outstanding problems of chemical theory of to-day, particularly the phase bearing on the structure of the natural products of high molecular weight. The nature of these forces, which in a general way may be termed molecular in distinction to the primary-valence atomic forces, as yet is unknown. Their existence, however, nobody familiar with substances related to sugar, namely, α-hydroxy aldehydes, will ever doubt. For these substances remain in monomolecular state only for a brief space of time and pass spontaneously with the evolution of heat into a dimolecular, as if by this means liberating energy which subsequently may be utilized for the condensation of the simple substances into those more complex. Whether or not the complex substances such as starches, cellulose, gums, proteins, lignins, etc., are the products of molecular or of atomic forces is as yet not certain but the work on sugars now in progress in many laboratories is bound eventually to furnish the answer.

The most monumental contributions of sugar chemistry belong to the chapter on stereoisomerism. At the time Fischer began his researches on sugars, stereochemistry was a novelty looked upon with scepticism by many and was not tested experimentally from the view-point of predictions which the theory permitted. Fischer set out to test these predictions on sugars and verified the theory completely. Thus, sugar chemistry, more than any other branch of our science, helped to gain recognition for the

views of van't Hoff and Le Bel. In the hands of Hudson the sugars attained another triumph by furnishing evidence to the optical superposition theory of van't Hoff. This triumph is of special significance for the reason that it was based not on a qualitative but on a quantitative method, and a science enters the category of an exact science only when it is based on quantitative arguments.

The contributions of sugar chemistry to stereochemistry go beyond those points. The more intimate knowledge of the relationship between structure and optical activity will depend upon establishing configurational relationships between simple substances containing one asymmetric carbon atom. The early work in this direction was based upon the knowledge of the configurations of simple sugars and of the acids derived from them.

One of the very disturbing observations in the field of stereochemistry was made by P. Walden in 1893 when he found that the reaction of substitutes on an asymmetric carbon atom may be accompanied by a stereochemical inversion. The observation, since then known as the Walden Inversion, has intrigued many chemists, and again the sugars offered a valuable medium for the study of the phenomenon.

From all that has been said, an impression may be gained that for the evolution of chemical theory sugars played rather a modest rôle to test theories which came to the front through observations in other fields of chemistry. At least one case may be mentioned where the observations on sugars suggested a new thought, the one of the possibility of an asymmetry produced by a carbon atom combined with three other groups only. It was the observations on the ethyl ester of the diazogluconic acid which suggested the possibility of the existence of optically active aliphatic diazoësters.

Finally, it would be no exaggeration to state that the most recent phase of sugar chemistry holds out more promise of general significance than any of the preceding phases. It deals with the migration of groups in the partially substituted sugars and with the dynamic isomerization of ring structures.

Passing now from organic to bio-chemistry, we find that there also sugars contributed much to theory. The difficult and exhaustive work done by Nef on the dissociation of sugars had for its objective the explanation of the process of fermentation. The work of Evans aims at the same end. The problem of fermentation is one of the most important problems of general biology, not because of the commercial or medicinal value of alcohol, but because the process of utilization of sugars by higher and lower living forms in many respects resembles that of fermentation and because what is learned about one of these processes may help towards understanding the other. The mechanism of biological dissociation of sugar as it is seen to-day could not have been conceived without the preceding work on the chemistry of sugars. It is enough to mention the discovery of phosphoric esters of the sugars as an essential step in fermentation as well as in animal combustion of sugar.

Above all, sugars have contributed to our understanding of the most important biological agents, the enzymes, the agents which occupy the intermediate place between non-living and living matter. For it was sugar chemistry which removed much of the mystery of the nature of these agents and placed them in the category of simple chemical substances acting in solution. How else can one explain the stereospecificity of the enzymes? The deduction formulated by E. Fischer in regard to relationship between enzyme and substrate, when the substrate was a sugar, is now accepted in relation to practically all enzymes.

All the contributions of sugar chemistry to general chemical theory, however, were the result of the progress in the knowledge of the details in the structure of simple and complex sugars. It is therefore appropriate to enumerate briefly the landmarks in the history of sugar chemistry. I should like to begin the modern history of sugar chemistry with the name of Butlerow, who was the first to prepare a sugar from the simplest components—from formaldehyde. No really great progress was made after the days of this Russian chemist until Kiliani's synthesis of sugars. On the foundation of Kiliani's work and on the basis of van't Hoff's theory, Fischer erected the wonderful structure of the stereochemistry of sugars. Mention also should be made of Tollens' suggestion of the cyclic structure of glucosides. After Fischer's work was completed, it seemed as if human ingenuity had exhausted all the accessible knowledge in the field of sugar chemistry. But then two new methods came to the front, the result of which is the recent work in the field of sugar chemistry.

One of the methods is that of methylation first introduced by Purdie and made popular by Irvine and the second is the application to sugars of van't Hoff's optical superposition theory by Dr. Hudson. About his latest work on the ring structure of sugars you have heard from him personally, and the gathering here to-night is evidence of your appreciation of this work; but may I remind you of Dr. Hudson's earlier pioneer contributions—which are as serviceable to-day as they were on the dates of their discovery. They are:

The rational classification of alpha and beta forms of sugars and of glucosides. All sugar chemists still remember the arbitrary manner of the older classification and the chaotic state of nomenclature of the various forms of glucose and of other monosac-

charides. Hudson's rule then permitted him to elucidate the alpha and beta structure of di- and trisaccharides, a problem which previously could be solved only with much difficulty.

Then came the rule correlating the structure of lactones with their optical properties. This rule subsequently played an important part in determining the ring structure of glucosides.

Then came the amide rule of rotation which permitted the correlation of the structure of hydroxyacids and sugar acids, and as by-products of his theoretical work are many discoveries of new forms of isomerisms and of rearrangements.

It is a rare occurrence that a single principle has led to so many discoveries. All sugar chemists of to-day have been assisted in their work on more than one occasion by the rules which are known as Hudson's rules.

MICHAEL FARADAY. II[1]

By Dr. W. F. G. SWANN
BARTOL RESEARCH FOUNDATION

IN the fall of 1831 Faraday began the first section of his great work, "Experimental Researches in Electricity," the work which he continued for some twenty-three years. These researches appear from time to time as papers transmitted to the Royal Society and they were subsequently put together in a single set of three volumes. They give a most detailed description of his thoughts and work. Experiments are described in the minutest detail. Every paragraph is numbered consecutively from beginning to end, and cross references are added to serve as connecting links between the various researches. His first experiments are on the induction of electric currents. Following the general notions evolving from the known facts that charged bodies induce electrical charges in others in their vicinity, he inquires whether any such phenomena can occur in the case of electric currents. Such problems as these present themselves to him. Suppose we have a wire in which a current is flowing, do we alter in any way the magnitude of that current by bringing into its vicinity another wire carrying a current? The kind of effect he is looking for is one where there will be some permanent alteration or at least an alteration which will persist for the whole of the time that current No. 2 is brought into the vicinity of current No. 1. He makes tests in all sorts of different ways and is finally led to the now well-known result that the induced current occurs only at the moment of change of the other current or during the periods of motion of the circuit carrying that current. Nevertheless, the nature of these phenomena is such as to cause his mind to lay hold of the idea that the various circuits which are involved are not actually ignorant of each other's presence. He thinks of them as being conscious of that presence in sort of a silent way. He thinks of them as being in what he calls an electrotonic state. His mind lays hold of the thought that it is in the change of that state that the current manifests itself. In order to appreciate the whole significance of his attitude in this matter, we must transport ourselves to a state of mind where we do not have the pictures of lines of force which we enjoy to-day. All that came later as an extension by Faraday himself of the ideas which he formulated in the early history of the subject. We have before us simply a set of wires all apparently unconscious of each other's presence. Yet any one of them has the power to know if any change is made in the other. It is one of the characteristic features of Faraday's way of thinking that he seemed to have the faculty of arriving at the essential elements which matter in a qualitative form long before he was able to place that exact significance to them which is associated with quantitative relationships. The quantity which was associated with the electrotonic state appeared in the hands of Clerk Maxwell as the electromagnetic momentum associated with the circuit. Or in terms of more intuitive concepts it refers to the product of the current and the total flux of magnetic induction through the circuit. It is this quantity, a purely mathematical quantity having no physical significance in the ordinary sense of the word, which Faraday succeeded in ferreting out of his experiments as the quantity essential for the coordination of his results. Speaking of this electrotonic state, as visualized by Faraday, the great Clerk Maxwell writes:

> By a course of experiment, guided by intense application of thought, but without the aid of mathematical calculations, he (Faraday) was led to recognize the existence of something which we now know to be a mathematical quantity, and which may even be called the fundamental quantity in the theory of electromagnetism. But as he was led up to this conception by a purely experimental path, he ascribed to it a physical existence, and supposed it to be a peculiar condition of matter, though he was ready to abandon this theory as soon as he could explain the phenomena by any more familiar forms of thought. Other investigators were

[1] An address given on February 14, 1931, at the Massachusetts Institute of Technology, under the auspices of the Department of English and History.

long afterwards led up to the same idea by a purely mathematical path, but so far as I know, none of them recognized, in the refined mathematical idea of the potential of two circuits, Faraday's bold hypothesis of an electrotonic state. Those, therefore, who have approached their subject by the way pointed out by these eminent investigators who first reduced its laws to a mathematical form have sometimes found it difficult to appreciate the scientific accuracy of the statements of laws which Faraday, in the first two series of his "Researches" has given with such wonderful completeness.

The scientific value of Faraday's conception of an electrotonic state consists in its directing the mind to lay hold of a certain quantity, on the changes of which the actual phenomena depend. In spite of the fact that the experimental researches of Faraday do not contain a single line of mathematics, Maxwell refers to him as one of almost unrivaled mathematical insight. Speaking in another place he remarks:

> It was perhaps for the advantage of science that Faraday, though conscious of the fundamental forms of space, time and force, was not a professed mathematician. He was not tempted to enter into the many interesting researches in pure mathematics which his discoveries would have suggested if they had been exhibited in a mathematical form, and he did not feel called upon either to force his results into a shape acceptable to the mathematical taste of the time, or to express them in a form which mathematicians might attack. He was thus left at leisure to do his proper work, to coordinate his ideas with his facts, and to express them in natural, untechnical language.

A guiding principle which we find operative again and again in Faraday's activities is his belief in the unity of nature, the belief that the various phenomena which manifest themselves in different ways through magnetism or electrically, etc., are all fundamentally of the same kind. Indeed in these researches on the induction current, he speaks of the evolution of electricity from magnetism.

It had been observed by Arago that if a plate of copper be revolved close to a magnet needle suspended in such a way that the latter could rotate in the plane parallel to that of the former, the magnet tended to follow the motion of the plate. Faraday proceeds to discuss this phenomenon and to develop the theory of its action. Then he sets up an experiment in which he revolves a copper disc between the poles of a magnet and makes contact between the edge and the center to a galvanometer. A continuous current is produced, and the first dynamo is in operation. He then applies these ideas to the induction of current in the earth as a result of its rotation in its magnetic field, and draws interesting conclusions concerning the effects upon terrestrial magnetism. He makes experiments upon earth currents on the Thames, and obtains the permission of the king to make experiments at the lake in the garden at Kensington Palace.

At the present time, when our views as to the significance of an electric current have become so concrete, it is well to remind ourselves that in the early stages of the sciences it was by no means obvious that those things which we now call electric currents were of the same character regardless of their mode of production. The realization of a current of electricity from electrostatic charges, from a voltaic cell, and from electromagnetic induction, involves such a diversity of methods in the production of the phenomena that, in the early history of the subject, the question of the identity of electric currents produced by different means was one whose solution was by no means obvious. The importance of a solution to the problem was very evident to Faraday. "It was essential for the further presentation of my inquiries," he writes, "that no doubt should remain of the identity or distinction of the electricity excited by different means." Then by a series of carefully planned experiments he proceeded to test this all-important question and to reach the solution that the apparent differences, striking as they may be as regards the method of production of the current, have no effect whatever upon the nature of the current itself. The high spot in his demonstration of the similarity of different kinds of current was attained in his showing that all of them were able to produce decomposition of certain chemical compounds into their element. These researches led him into a careful examination of the subject which we now know as electrolysis.

That the chemical substances could be broken up by the agency of an electric current was well known, but the mechanism of the process was in a very unsatisfactory state. It was generally assumed that the conductors by which the current entered and left the solution produced an electric field which had the power of tearing the atoms asunder. Faraday realized that such a procedure was entirely inadequate to account for the facts; for, apart from all other considerations, on such a view, it would follow that the slightest electrical tension would be more powerful than the strongest bonds of chemical affinity, since the slightest current would cause chemical decomposition. By an elaborate series of experiments attacking the matter from all sorts of points of view, he finally established the conclusion that the rate of chemical decomposition in any given substance is absolutely independent of all consideration other than the current which passed through it. It matters not whether the electrodes are small or large or even whether there be any electrodes at all. The current alone was the quantity which played the vital part. And so Fara-

day established his well-known First Law of Electrolysis; and his celebrated voltameter, whose action rests upon the definite proportionality between rates of chemical decomposition and current, served for many years as the only practicable method by which quantities of electricity could be accurately measured. In connection with these various researches he came to the establishment of certain well-known terms which exist in the literature of the subject to-day. The wires by which the current entered and left the substance which was being decomposed he termed the electrodes, and the substance which was deposited upon those electrodes he called "ions" or "wanderers." The substances which went to these electrodes he called, respectively, anions and kations. One of the electrodes he called the anode and the other the kathode. To the decomposition itself he gave the name electrolysis and substances which were capable of being disintegrated by the electric current he termed electrolytes. It is a characteristic feature of Faraday's mental process that, while he thought of the working entities of nature in a most realistic way, having formulated his concepts, he sought to remove from them as many irrelevant appendages as were unnecessary for the performance of their desired functions. The very term of electricity itself was somewhat distasteful to him as implying a type of mechanism which was not necessarily a unique representative of the experimental facts. Continuing his study of the decomposition by the electric current, he finally came to the formulation of his second law of electrolysis which states that if the same current be passed through different electrolytes in series, the weights of the different substances deposited in a given time are proportional to the chemical equivalent of the substances.

He next takes up the question of the origin of the electromotive force in the voltaic pile, which, it will be recalled, consists of an alternating series of the following kind. First, we have a copper disc, then a piece of blotting paper soaked in a solution, then a zinc disc, then another copper disc, then another piece of paper and so on. It had been customary to suppose that the seat of power in this pile lay in the contact of the metal surfaces, and such a theory was supported by many eminent philosophers. Faraday had become imbued with the conviction that the production of the electric current was associated with chemical decomposition. His experiments on electrolysis showed that the current passing through an electrolyte caused such decomposition, and in the mechanism of the voltaic cell itself he saw a similar phenomenon taking place, the only difference being that here the chemical action took place in the reverse manner.

> The contact theory [he urged] assumes that a force which is able to overcome powerful resistance, as for instance that of the conductors, good or bad, through which the current passes, and that again of the electrolytic action where bodies are decomposed by it, can arise out of nothing: that without any change in the acting matter, or the consumption of any generating force, a current shall be produced which shall go on forever against a constant resistance or only be stopped as in the voltaic trough, by the ruins which its exertion has heaped up in its own course. This would indeed be a creation of power, and is like no other force in nature. We have many processes by which the form of the power may be so changed that an apparent conversion of one into the other takes place. So we can change chemical force into the electric current, or the current into chemical force. The beautiful experiments of Seebeck and Peltier show the convertibility of heat and electricity; and others by Oersted and myself show the convertibility of electricity and magnetism. But in no case, not even in those of the Gymnopodous and Torpedo, is there a pure creation or a production of power without a corresponding exhaustion of something to supply it.

Here in this statement, made before the time when Meyer had published his "Essay on the Forces of Inorganic Nature," and before Joule had performed his experiments upon the mechanic equivalent of heat, we have a foreshadowing by Faraday of the principle of the conservation of energy.

These investigations in electrolysis and the like occupied him until the end of the year 1834, when his attention was directed to the whole question of electrostatic induction. The poles of the voltaic battery had suffered a great loss of prestige in his hands. He seems to see in them nothing but flag poles announcing what is going on in the medium between them, and so he becomes suspicious of the whole idea of electric charges on conductors acting upon each other through the intervening medium. He sees that a so-called charged body can induce a charge on another one which is screened from it in the optical sense, *i.e.*, in the sense that one body would be invisible from the other. The effect attributed to the body A has a mysterious property of being able to travel around the corner and visit body B. And so he comes to concentrate his mind more upon the medium itself than upon the so-called charges on the various bodies. The body is to him merely the means by which the action of the medium is supposed to become apparent. Moreover, the charge distribution produced on the body B by the presence of a charged body A is altered by changing the nature of the medium between the two, as, for example, by the interposition of a sphere of wax. Thus action at a distance has to take some cognizance of the medium

between. He sees the medium as a seat of some kind of strain associated with his lines of force. A dielectric is a substance which is capable of sustaining the electrical strains, while a conductor is one which for reasons at the time unknown was unable to withstand it and yielding to it gives rise to an electric current. Hence these lines of electric force end abruptly when they fall upon a conductor. The electric charges (and Faraday dislikes the very word charge) which appear on the conductors are thus only the termination of these lines of force, one end of the line being positive and the other end negative. Like stretched cords these lines tend to contract while they exert also a lateral repulsion against each other which holds them in equilibrium. It was not until a much later date that Maxwell represented in elegant mathematical form this concept of Faraday, and actually found the magnitudes of the pressure and tension which it was necessary to associate with the medium in order that the lines of force as Faraday conceived should hold themselves in equilibrium. When one reads through Faraday's experimental researches and finds in them no mathematical formula, one sometimes wonders whether a person of his intuitive powers of conception may not, as a result, have limited his vision as to the generality of the possibilities. The more closely we read, however, the more we see that even when delving in those realms which are the natural field of mathematical analysis, he has an uncanny way of knowing exactly what he is doing. His concepts developed in terms of lines of force grew stronger and stronger during the whole of his life of investigation; and, yet, he was fully aware of the fact that in spite of the great reality with which the lines stood out to him in his thought, they were only one way of viewing the phenomena, but a way which he regarded as particularly efficient for the purposes of those phenomena. Writing at a much later date he says, speaking of magnetic lines of force, although the arguments are the same:

> Now it appears to me that these lines may be employed with great advantage to represent the nature, condition, direction and comparative amount of the magnetic forces; and that in many cases they have, to the physical reasoner at least, a superiority over that method which represents the forces as concentrated in centres of action, such as the poles of magnets or needles; or some other methods, as, for instance, that which considers north or south magnetisms as fluids diffused over the ends or amongst the particles of a bar. No doubt, any of these methods which does not assume too much, will, with a faithful application, give true results; and so they all ought to give the same results as far as they can respectively be applied. But some may, by their very nature, be applicable to a far greater extent, and give far more varied results, than others. For just as either geometry or analysis may be employed to solve correctly a particular problem, though one has far more power and capability, generally speaking, than the other; or just as either the idea of the reflection of images, or that of the reverberation of sounds may be used to represent certain physical forces and conditions; so may the idea of the attractions and repulsions of centres, or that of the disposition of magnetic fluids, or that of lines of force, be applied in the consideration of magnetic phenomena. It is the occasional and more frequent use of the latter which I wish at present to advocate.

The researches on electricity and magnetism so far reviewed occupied Faraday for a period of about ten years. A few personal incidents of this period are of interest. Sir Robert Peel, with the idea of rewarding and encouraging science and literature, had instituted the system of the Royal Pension to be granted to men of distinction, the grants being made in such a form as to render them acceptable without the appearance of receiving charity. One of these pensions was intended for Faraday, but Sir Robert Peel was out of office before the matter matured in his case, and it fell to the lot of the new prime minister, Lord Melbourne, to invite Faraday to an interview upon the subject. His lordship was evidently not sympathetic with the whole proposal and evidently conveyed his impression during the conversation. It is said that he referred to this giving of pensions to scientific and literary men as so much "humbug," and it is even said that he qualified the word humbug with an epithet which Faraday described as "theological." Faraday's dignity was hurt and he brought the interview to a close. A few hours later, he called upon the prime minister, and left his card with a note, "Declining to accept at your Lordship's hand that which through it has the form of approbation, is of the character which your Lordship so pithily applied to it." Lord Melbourne seems to have treated the matter at first as a joke, but being made conscious of its seriousness by friends who had a greater appreciation of Faraday's work than he had, and being, moreover, apparently a good-natured kind of soul, he became anxious to put the matter through in spite of all. However, Faraday would have nothing to do with the pension until the offensive word had been withdrawn and apologized for. It is a happy reflection upon the character of Lord Melbourne that he saw a greater salvage of the dignity of England's prime minister in honorable retraction of the offensive words than in resting dignity upon the false pride of office, and leaving a shadow which in later years could only have filled with chagrin the hearts of those who respected him.

The strain of the years of activity upon which Faraday had spent his energy up to the end of the first period of his electrical researches had resulted

in repeated attacks of bad health, the attacks taking the form of headaches, dizziness and occasional loss of memory. He would be apt to forget some of the experiments that he himself had performed and was unable to make use of his own investigations for the purpose of further advance. At the beginning of 1841 the trouble became so pronounced that he was advised to take a complete rest; and, for a year his work at the Royal Institution was interrupted. His rest took the form of a trip abroad in which as usual he gives a most detailed account of what he did and saw. The beauties of nature are a never-ending source of delight to him, and finally he and his wife returned to England at the end of the year, his health much improved, although it is doubtful if he ever completely recovered from his breakdown.

The second period of his researches occupied the years from 1845 to 1855. Faraday was endowed with an overwhelming conviction concerning the unity of nature, and he was continually trying to see relationships between different parts of science which at first seemed disconnected. The first paper of his second series of experimental researches in electricity dealt with the rotation of the polarization of light in a magnetic field. It has a rather curious title "The Magnetization of Light and the Illumination of Magnetic Lines of Force," a title which gave rise to some misunderstanding as to its significance. The paper starts with the sentence:

> I have long held an opinion, almost amounting to conviction, in common I believe, with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; or, in other words, are so directly related and mutually dependent that they are convertible, as it were, one into another, and possess equivalents of power in their action. In modern times the proofs of their convertibility have been accumulated to a very considerable extent, and a commencement made of the determination of their equivalent forces.

In a later paper he proceeds to test a possible relation between gravity and electricity, endeavoring to obtain electric currents by moving coils in the earth's gravitational field in all sorts of different ways. These experiments bear no fruit, but he nevertheless ends the description of them with the statement, "Here end my trials for the present; the results are negative but they do not shake my strong feeling of the existence of a relation between gravity and electricity, though they give no proof that such a relation exists." To this period of Faraday's activities belongs his discovery of the magnetic characteristics of materials. The words "paramagnetic" and "diamagnetic" are introduced by him, and he makes an exhaustive examination of these phenomena in all sorts of different substances including gases. He is particularly interested in the paramagnetic characteristic of oxygen, and thinks that he sees in it, when combined with the temperature variations, an explanation of the variations of terrestrial magnetism. Then we have a long discourse on lines of magnetic force within and without a magnet, and the citation of many of those experiments on unipolar reduction which have occurred so frequently in discussion in the literature, up to the present time. An experiment cited by Faraday is one in which a cylindrical magnet is mounted so that it can revolve about its axis. A wire is joined from one pole of the magnet to the equatorial belt of the magnet through a galvanometer. It is experimentally found that on rotating the magnet and wire together no current is observed in the galvanometer. On the other hand, if either the magnet or the wire be rotated separately a current is produced. The explanation of these effects is one which has puzzled a great many people. In fact, physicists divide themselves into two classes. First we have those who are familiar with the mathematical theory, and to them everything is perfectly clear in the sense that it is all explained by the equations. Then there are those who think intuitively in terms of lines of thought, and in whom a large part of their knowledge of the subject is bound up in the statement that when lines of force cut across a conductor either by the motion of the field or by the motion of the conductor, an electromotive force is produced which is proportional to the rate of cutting off the line. Arguing on this basis, they find a great deal of difficulty in understanding the experiment. They are apt to think of those lines of force of the magnet visualized in the shape of material threads attached to the magnet, so that when the magnet is rotated, these lines partake of the rotation. Such a state of affairs leads to erroneous conclusions as regards the currents excited. The mathematical theory leads to the conclusion that any interpretation which is to be made in terms of the cutting of lines of force must be one in which the lines of force of the magnet do not participate in the rotation. On the other hand, if one takes the magnet as a whole and moves it without rotation in the vicinity of a wire circuit, the electromotive force is accurately calculable in terms of the rate of cutting of the lines, where those lines are considered as carried along with the magnet in its motion. It is an astonishing thing that a large number of physicists who are keen in their judgment but do not happen to have the mathematical technique at hand find the greatest difficulty in getting the right point of view in this matter. Nevertheless, Faraday, who was in this group in the sense that he did not have the mathematical technique wherewith to handle the equa-

tions, and in fact the equations did not exist at that date, had formed a perfectly definite conception of the attitude which must be adopted toward lines of force and their motion in order that the conclusion to be expected should agree with the facts. Thus he writes:

> When lines of force are spoken of as crossing a conducting circuit they must be considered as effected only by the translation of a magnet. No mere rotation of a bar magnet on its axis produces induction effects on circuits exterior to it; for then, the conditions above described are not fulfilled. The system of power about the magnet must not be considered as necessarily revolving with the magnet, any more than the rays of light which emanate from the sun are supposed to revolve with the sun. The magnet may even in certain cases be considered as revolving amongst its own forces, and producing a full electric effect, sensible at the galvanometer.

This statement shows that Faraday had no difficulty at all in adjusting his mental attitude so that a motion of lines of force along with the magnet when in translatory motion was in every way consistent with a view which considered them as stationary in respect to the rotation of the magnet. If one tries to visualize these lines too completely, there is a danger of an inconsistency arising between these two view-points. How is it possible, one may say, that the magnet can rotate without its line going around with it like a squirrel cage? It is an example of the peculiar power of Faraday's reason that he was able to see just how far he could materialize the association of these lines with the magnet so as to give him the maximum of mental satisfaction without forcing into them a spurious concept of reality in relation to their attachment to this magnet which would have been contradictory to the facts. Another example of his power to make physical intuition his servant rather than his master is found in his supposing that in the case of a bar magnet, for example, the lines of force pass continuously around the outside of the magnet through the magnet itself, so that in the substance of the magnet they travel in the opposite direction to the field one would think of there, if he pictured to himself the magnet simply as a pair of poles. In spite of the fact that this property of magnetic lines of force, or rather lines of induction, as we have come to call them in this case, is insisted upon in all the text-books, I wonder if there are many students in the unsophisticated stage who really understand what is meant. If one tries to think of the phenomena in terms of a magnet made up out of smaller magnets, each with a pair of poles, the magnetic induction within the substance assumes the form of a mathematical vector to which there is no direct physical significance in the sense in which one pictures the actual forces between the various elementary poles of which the little magnet is composed. Even if the elementary magnets be replaced by amperian current whirls or by rotating electrons, the actual field within the interstices of the atoms assumes a highly complex form, and it is only in the sense of an average quantity that this vector, the magnetic induction within the substance, assumes a concrete form. However, it is a quantity which is certainly definite in the same sense that the average magnetic energy of a whole lot of molecules is a perfectly definite thing, a thing in fact directly associated with the temperature of the substance; and, to Faraday, the quantity became concrete as soon as it was possible to define it in terms of its properties. He early seized upon the fundamental characteristics of these lines of force or induction, the characteristic which provides for what in the mathematical theory is called the solenoidal condition, the characteristic which provides for the fact that the total flux of lines through any closed surface is equal to zero, so that the outward flux through one portion of the surface is equal to the total inward flux through all the other portions. In speaking of this matter he speaks with a conviction which goes even beyond the mere experimental requirements that a conclusion must be true. For he says:

> I regard the destruction of force, and still more emphatically of one form only of a dual force, is as impossible as the destruction of matter. All that is permitted under the general laws of nature is a displacement of the force and these conditions are as true of the smallest suppressions of force or part of a force as of the suppression of the whole.

His picture of electromagnetic phenomena becomes painted entirely in terms of these tubes of force. It is in terms of the rate of change of flux through a surface that he ultimately expresses the story of the induced current therein; and so through the agency of these tubes of force he realizes what is now to him the physical significance of that quantity which in his early researches he associated with what he called the electrotonic state, the quantity which in the hands of Maxwell figured as the electromagnetic momentum of the circuit concerned. The concept of polarity becomes repugnant to him in electrostatics and in magnetism, as it had become repugnant to him in the theory of the voltaic cell. He raises the question, "What is magnetic polarity and how is it to be defined?" He goes on to say, "For my own part, I should understand the term to mean the opposite and antithetical actions which are manifested at the opposite ends or the opposite sides of a limited, for instance, or unlimited, portion of a line force." Later he says, "If the term polarity has any meaning which has reference to experimental facts and not to hypothesis which is not included in the above description, I

am not aware that it has ever been distinctly and clearly expressed."

In all these researches of Faraday, one has to remember that he was working in a time when one did not think in quantitative terms, as we do to-day. There was no ohm, no ampere and the like in terms of which to talk. When he speaks of measurements he talks in such terms as: "the voltaic current which I used upon this occasion was that of five pair of grove cells. The electromagnets were of such power that the poles would seem to sustain a weight of from twenty-eight to fifty-six or more pounds." Then again when citing experiments on the effects of different quantities of charge he talks of the number of rotations which he makes in the wheel of his electrical machine. On the other hand, in these experimental situations, just as in his theoretical discussion, he shows an intuition so well described by one who said, "He smells the truth." In using the crude galvanometers of the day to investigate some of the phenomena of induction, he comes to the conclusion that it is better for the purpose in hand to use an instrument with one turn in its coil than to use one with many. For he says, "Such a wire had abundant conducting power; and though it passed but once around each needle, gave a reflection many times greater than that belonging to the former galvanometer." Again when he is obtaining current from a battery of cells he finds that it is better to join them up in a combination of what we call series and parallel, than to adopt either of these methods exclusively. The only place where he gives a suspicion of failing in a minor way to recognize the full significance of the elements involved is where, on making a simple arithmetical calculation concerned with measurements which are necessarily rough and semiqualitative in nature, he expresses his calculations and results to seven significant figures.

Some of his last work concerns meditations on the nature of light which he tried to visualize simply as undulations of his line of force; and, while he did not carry the development of this matter very far, it is significant that here also he "smells the truth"; for, as so vividly portrayed in the calculations of radiations, we see the essential element of the electromagnetic waves, from a charged particle in motion, for example, as resulting from a super-position of ripples upon the lines of force of the charge in such a manner as to leave intact the permanence of those lines of force as regards the constancy of their flux through a closed surface surrounding the charge.

And so we come to the close of the career of this great prince of experimentalists whose labors fired the spark which has illuminated the whole realm of modern physics. As age crept on, his forgetfulness increased more and more. His last lecture was delivered in 1862, and the same year saw his last experiment. As he felt his powers weaken he laid aside his duties one by one. He was invited to assume the presidency of the Royal Society but declined. It was inevitable that the managers of the Royal Institution should feel it fitting that, as his career drew to a close, he should be asked to be president of the institution to which he had brought such lasting fame. But he felt that the duties of this position, if conscientiously performed, would be beyond his powers at the time, and he was not one to take the task and, in carrying it through, fall below the standard set by his very high ideals. The closing years of his life were spent near Hampton Court in a house placed at his disposal by the Queen in 1858; and it is a comforting thought that in spite of the weakening of his powers time treated him kindly as regards his general health. He suffered from no disease, and his end came without pain on the 25th of August, 1862, while seated in a chair at his desk.

OBITUARY

NORIFUMI OKAMOTO

On February 17, 1931, Japan lost one of the foremost scholars in the field of the history of her native mathematics, Mr. Norifumi Okamoto. In the oriental countries it is not enough that such a man should be well versed in mathematics as a science; for this he may be without the ability to read with any ease the works of the classical writers of his own language. This is due to the fact that modern mathematics makes use of terms and methods unknown to ancient writers, whereas the terminology used by the latter is like medieval Latin words to a modern student of analysis. In the person of Mr. Okamoto both necessary elements for the interpretation of the classics were combined, for in his youth, before the Restoration, he was taught the mathematics of the past, and after the abolition of the shogunate he took up the study of the occidental works in the same field. He was one of a band of young and enthusiastic teachers to make the first Japanese translations or adaptations of European text-books and thus to bring into the modern schools of his country the ideas of the western world.

When the Japanese government decided to establish normal schools as part of its modernizing program he was appointed the principal of one of these institutions, and when the Peers' College was founded it was to him that the authorities turned for advice,

and it was he who became the first head master. In later years he taught in the Military Officers' School at Tokyo, and was for a time the superintendent of the Seijo Gakko, or Middle School. During all these years he devoted a great deal of time to the study of the mathematical classics, fitting himself to become a worthy successor to Mr. Endō, whose work on the history of Japanese mathematics is deserving of being ranked as itself a classic. He was also much interested in the subject of geometric transformations as treated by Ushijima Seiyo and Hodoji Zen and had planned to publish a work upon the subject, a project that he did not live to carry out.

For some years before his death he was engaged in preparing a catalogue of the large collection of early Japanese mathematical manuscripts and printed books in the Imperial Academy at Tokyo, a line of work for which he was admirably fitted.

In manner he was a "gentleman of the old school," kindly and yet reserved. He wrote but little, always hesitating to put on paper that which he felt to be in need of further perfecting. Perhaps it was as well that this was the case, since it left him more time for work upon the library, a task which was left unfinished but which was complete as far as he went.

I am indebted to friends in Japan for much of the above information concerning Mr. Okamoto's life, and to my own impressions of him formed on a visit to the library only a year ago. If Japan should induce Mr. Mikami to carry on the labors of his friend, this would be looked upon by western scholars as fortunate for the development of the history of the native mathematics of that country.

DAVID EUGENE SMITH

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

MEMORIALS

DR. GEORGE H. BIGELOW, commissioner of health of Massachusetts, will deliver the sixth Hermann M. Biggs Memorial Lecture, May 7, at the New York Academy of Medicine. The subject of the lecture will be "Will Physicians Practice Preventive Medicine?" The lectureship, founded by the widow of Dr. Biggs, was until this year administered by the New York Tuberculosis and Health Association and the Medical Society of the County of New York. Previous lectures were given by Dr. William H. Park, 1925; Dr. S. Lyle Cummins, Cardiff, Wales, 1926; Dr. Allen K. Krause, 1927; Dr. Charles-Edward A. Winslow, 1928, and Dr. John H. Stokes, 1929.

THE issue of *Wiener medizinische Wochenschrift* for March 14 is dedicated to the memory of Professor von Basch, the father of clinical sphygmomanometry, who died in 1905.

IT is planned under the auspices of the academy at Béarn to erect a monument at Pau to Charles Moureu, the organic chemist who died on June 13, 1929, in memory of his services to science. The monument will be executed by the sculptor E. Gabard. Busts will be placed in the Collège de France and the Faculté de Pharmacie in Paris.

RECENT DEATHS

PROFESSOR FRANCIS X. DERCUM, from 1892 to 1925 professor of nervous and mental diseases at Jefferson Medical College, Philadelphia, since 1925 professor emeritus, died suddenly on April 23 while presiding at the business session of the annual meeting of the American Philosophical Society, which he had served as president for seven years. Dr. Dercum was seventy-four years old.

THE death is announced of Dr. George Martin Kober, professor of hygiene and dean of the School of Medicine of Georgetown University until his retirement as dean emeritus in 1928, on April 24. Dr. Kober was eighty-one years of age.

DR. JOHN A. FOOTE, pediatrist and dean of the Georgetown University Medical School, with which he had been connected twenty-five years, died on April 11, at the age of fifty-seven years.

PROFESSOR ARTHUR J. WOOD, head of the department of mechanical engineering at Pennsylvania State College, died on April 18 from injuries he received when he was struck by a motorcycle. Professor Wood was past president of the American Society of Refrigerating Engineers, former associate editor of *The Railroad Gazette*, and until 1918 associate editor of *Railroad Mechanical Engineering*.

EDGAR BOYD KAY, formerly dean of the School of Engineering of the University of Alabama and chief of the hydraulic and sanitary division, quartermaster's office, United States Army, has died, at the age of seventy-one years.

THE death is reported by *The British Medical Journal* of Dr. Jean Baptiste Coppez, professor of ophthalmology at Brussels from 1891 to 1905, aged ninety years; Dr. Auguste Slosse, professor of physiological chemistry at Brussels; Dr. Paul Frangenheim, professor of surgery at Cologne and an authority on bone surgery, aged fifty-four years; Dr. Giulio Tuno, a physiologist of Rome, and Professor Vogt, a Moscow pathologist, aged eighty-three years.

THE death is announced of Dr. Hermann Matthes, professor of pharmaceutical chemistry in the University of Königsberg, and of Dr. Wilhelm Semmler, professor of chemistry at the University of Breslau.

SCIENTIFIC EVENTS

THE ZOOLOGICAL SOCIETY OF LONDON

The annual report of the Zoological Society of London was recently issued. According to a summary printed in the London *Times* the assets amount to £178,202, an increase of £6,630 on the amount of last year, and the liabilities decreased by £1,064. Owing to the nature of the tenure of the ground occupied in Regent's Park the value of the buildings there can not be included in the assets, but, as the new estate of the society at Whipsnade is freehold, it is beginning to be a substantial asset. The income from fellows' subscriptions exceeded that of last year by about £1,000 and from gate-money also by over £1,000.

The report states that the experiment of opening the gardens on Thursday evenings, from June to September inclusive, begun last year, is to be continued this year, but a charge of 6d. is to be made for the aquarium, which was usually inconveniently crowded last year. Over 60,000 visitors entered the gardens on Thursday evenings after the usual time for closing the day admissions, and the council believe that the evening openings allowed many persons occupied during the day to visit the collection. As a strictly financial enterprise, however, the evening openings do little more than pay their way.

The pathologist reported that there were no serious epidemics among the animals, and that there had been a reduction in the mortality among mammals, birds, reptiles and amphibians. The following mammals were bred and reared: One pig-tailed monkey, one lemur, four galago lemurs, three lion-cubs, two pampas cats, one wolf, one sea-lion, two pygmy hippopotamuses, one Grévy's zebra, one kiang and one Mongolian wild horse, a water buck, two nylghaie antelopes, three black buck, one gazelle, one Wapiti deer, two Pudu deer, one reindeer, one Hangul deer, two American bison, two anoas, one yak, one Cape buffalo, one ibex, one Grecian wild goat, three Caucasian wild goats, nine Barbary sheep, nine moufflon, four thars, a Canadian beaver, a prairie marmot, three agoutis, a fruit-bat, two wallabies and two opossums.

The report announces that Whipsnade Zoological Park, although there will be many years before it is complete, will be opened to the public on Friday, May 22. On that day there is to be a "private view" for fellows and official guests, and from the following Saturday onwards it is to be open daily, including Sundays, to the general public from 10 a. m. until "lighting-up time." There are fully licensed premises for meals in the park and a car-park has been made ready opposite the only entrance yet available, about a quarter of a mile from the village of Whipsnade. Charabanc services are being arranged from the railway stations at Luton, St. Albans and Tring, as well as from London and centers in the Midlands.

The retiring members of council are Lord Alastair Innes-Ker, Professor J. P. Hill, Lord Onslow, Major Pam and Lord Rothschild. Those recommended to fill the vacancies are Sir John Bland-Sutton, Mr. H. G. Maurice, Sir Henry McMahon and Mr. E. G. B. Meade-Waldo, who have served on former occasions, and Sir Peter Clutterbuck, a Fellow who has not served before.

THE AMERICAN ASSOCIATION OF MUSEUMS

The annual meeting of the American Association of Museums will be held at Pittsburgh on May 21, 22 and 23, according to *Museum News*. General and group sessions are designed for delegates from museums of all kinds throughout the country. A general session each morning will be devoted to a topic of equal interest to museums of art, science, history and industry. Each afternoon session will be given over to a single paper introductory to inspection of one of the host museums or of some other branch of the Carnegie Institute. On two evenings six groups will hold separate sessions. At these group sessions more specialized topics will be considered, but in the aggregate a wide variety of subject matter will be covered. The groups are the technical section, the scientific section, the superintendents' section, the art group, the educational group, and the public relations group.

Important features of the meeting will be the twenty-fifth anniversary dinner on the third evening, and the exhibit of the technical section. The exhibit will be open for inspection throughout the meeting.

The delegates will be entertained at luncheon each noon and at tea each afternoon. Also a trip has been arranged for Sunday morning to the Allegheny Country Club, with luncheon on the lawn of the club.

The general session of the first morning will take up branch museums with papers on the different kinds of branches already to be found and general treatment of the needs and future. The second morning session will be on international outlooks with presentations from the European and the American standpoint and a critical comparison of views. The third general session, on the last morning, will take up outdoor education from the standpoints of science, history and art museums. At this session also there will be a single paper and discussion on a particular field—that of industrial museum exhibits.

Proposals for participation in the technical section exhibit are being received by Remi M. Santens, Carnegie Museum, Pittsburgh, vice-chairman of the sec-

tion. The exhibit will include models, miniature groups, manikins, photographs, drawings, paintings, case displays and designs. All members of the section who desire to submit objects for display should communicate with Mr. Santens.

DECREASE IN THE NUMBER OF SCHOOLS OF MEDICINE

MORE than 800 American medical students attempted to enter a single medical school in Scotland during 1930. This is brought out by Dr. Willard C. Rappleye in a chapter on medical education in the Biennial Survey of Education in the United States, 1928–30, issued by the office of education.

Medical study in America is becoming more popular year after year, although the number of institutions offering medicine is decreasing. Five thousand more medical-school applicants were reported in 1929–30 than in 1926–27. Last year 66 approved four-year schools graduated as many physicians as were graduated by twice as many schools 20 years ago.

Of nearly 4,500 graduates in 1929, more than half were from 24 to 27 years old. Nine were 21 years of age, and 89 were 35 years or older. The typical medical school graduate in this country is 25 years old. He completes a four-year course, and generally supplements his medical school training with a one-year interneship in an approved hospital before going into practice. A one-year interneship or some other acceptable work of the same nature is now required before a medical degree is granted by Pennsylvania, New Jersey, Alaska, Rhode Island, North Dakota, Washington, Michigan, Illinois, Delaware, Iowa, South Dakota, Utah, Wisconsin and the District of Columbia.

With one doctor to every 800 persons the United States has more physicians than any other representative country. In other countries the number of people to one medical doctor is: Switzerland, 1,250; Denmark, 1,430; England and Wales, 1,490; Germany, 1,560; France, 1,690; the Netherlands, 1,820; and Sweden, 2,860.

Curiously enough, of the seventy-eight medical schools in the United States the one having the largest enrolment is the University of St. Thomas, Faculty of Medicine and Surgery, in the Philippine Islands. The enrolment there is 896. Next ranks the University of Michigan Medical School with 594 male students when the survey was made. Jefferson Medical College of Philadelphia, Georgetown University School of Medicine, Northwestern University Medical School, University of Illinois College of Medicine, Harvard University Medical School, University of Minnesota Medical School and the St. Louis University School of Medicine also reported enrolments of more than 500 students.

In 1930 medical schools graduated only 204 women. The average number of women graduates per year since 1925 has been 205. Declines in the percentage of women graduates have been reported since 1926, however. The Woman's Medical College of Pennsylvania had a larger enrolment and graduated more women in 1930 than any other medical institution in the United States. One hundred and sixteen women were enrolled, and 14 were graduated from this college.

Dr. Willard C. Rappleye was director of study of the Commission on Medical Education which was organized in 1925 by the Association of American Medical Colleges to study the medical situation in the United States. Much of the information and statistics gathered is incorporated in this report.

DELEGATES TO THE NINTH INTERNATIONAL DAIRY CONGRESS

THE following delegates have been appointed by Secretary Hyde, and their nominations approved by the Department of State, to represent officially the United States at the Ninth International Dairy Congress, to be held at Copenhagen, Denmark, from July 14 to 17: From the department, O. E. Reed, chief of the Bureau of Dairy Industry; Nils A. Olsen, chief of the Bureau of Agricultural Economics, and R. R. Graves, chief of the division of dairy cattle breeding, feeding and management investigations, Bureau of Dairy Industry; Dr. C. H. Eckles, chief of the department of dairy husbandry, University of Minnesota; Professor M. Mortensen, head of the department of dairy industry, Iowa State College of Agriculture; Dr. J. M. Sherman, head of the department of dairy industry, Cornell University; C. E. Gray, president, Golden States Milk Products Company, San Francisco; O. F. Hunziker, director of research, the Blue Valley Creamery Butter Company, Chicago; Dr. E. V. McCollum, professor of biochemistry, the Johns Hopkins University, and C. L. Hill, chairman of the Wisconsin State Department of Agriculture. They will sail from New York on July 1, on *The George Washington*. The international dairy congresses are organized by the International Dairy Federation to help bring about cooperation by the dairy industries of all countries in promoting technical and scientific development of the industry throughout the world. Nine have been held since 1903—at Brussels in 1903, Paris, 1905, The Hague, 1907, Budapest, 1909, Stockholm, 1911, Bern, 1914, Washington, 1923, Paris, 1926, and London, 1928.

THE AMERICAN PHILOSOPHICAL SOCIETY

AT the annual meeting of the American Philosophical Society, held in Philadelphia on April 23, 24 and 25, the following members were elected:

Arthur Francis Buddington, associate professor of geology, Princeton University.

Ermine Cowles Case, professor of historical geology and paleontology, University of Michigan.

William Crocker, director of the Boyce Thompson Institute for Plant Research, formerly of the department of botany, University of Chicago.

Raymond Smith Dugan, professor of astronomy, Princeton University.

Alexander Forbes, associate professor of physiology, Harvard Medical School.

Simon Henry Gage, professor emeritus of applied histology and embryology, Cornell University.

Evarts B. Greene, professor of American history, Columbia University.

Alfred F. Hess, pediatrician, New York City.

Ernest A. Hooton, professor of physical anthropology, Harvard University.

Dugald Caleb Jackson, head of the department of electrical engineering, Massachusetts Institute of Technology.

Carl Otto Lampland, astronomer, Flagstaff Observatory, Arizona.

Waldo G. Leland, author and permanent secretary of the American Council of Learned Societies, Washington, D. C.

Wesley Clair Mitchell, professor of economics, Columbia University.

Alexander G. Ruthven, president of University of Michigan and director of the Zoological Museum.

Herman Augustus Spoehr, director for natural sciences, the Rockefeller Foundation.

Ernest Edward Tyzzer, professor of comparative pathology, Harvard University.

Willis R. Whitney, director of research laboratory, General Electric Company, and vice-president in charge of research since 1928.

Leicester Bodine Holland, architect, chief of the Division of Fine Arts, Library of Congress, and professor at the University of Pennsylvania.

Howard McClenahan, physicist, secretary and director of the Franklin Institute.

J. Henry Scattergood, Assistant Commissioner for Indian Affairs.

Walter S. Gifford, president of the American Telephone and Telegraph Company.

John D. Rockefeller, Jr., New York City.

Adolph S. Ochs, publisher of *The New York Times*.

Frank B. Kellogg, of the World Court and formerly Secretary of State.

Dwight W. Morrow, United States Senator from New Jersey.

The foreign members elected were:

Arthur Stanley Eddington, professor of astronomy, University of Cambridge.

Sir Arthur Keith, conservator of the Museum and Hunterian professor, Royal College of Surgeons of England.

Dr. Henry Norris Russell was elected vice-president, and the following officers were re-elected: Dr. James H. Breasted and Dr. Elihu Thomson, vice-presidents; Dr. Arthur W. Goodspeed and Dr. John A. Miller, secretaries; Dr. Albert P. Brubaker, curator, and Eli Kirk Price, treasurer. Mr. James M. Beck, Dr. Francis G. Benedict, Dr. Edwin G. Conklin and Dr. Lafayette B. Mendel were chosen as councilors to serve three years.

SCIENTIFIC NOTES AND NEWS

DR. THOMAS HUNT MORGAN has been elected a corresponding member of the Paris Academy of Sciences in the section for anatomy and zoology.

THE honorary doctorate of philosophy of the University of Berlin was conferred on Dr. R. W. Wood, professor of experimental physics at the Johns Hopkins University, at the German Embassy in Washington on April 27.

THE University of Cambridge will confer the honorary doctorate of science on Professor J. S. Haldane, director of the Mining Research Laboratory at the University of Birmingham.

HONORARY degrees conferred by the University of Aberdeen on April 3 include the doctorate of laws on Sir Leonard Erskine Hill, lately professor of physiology at the London Hospital and member of the senate of the University of London; on Sir Frank Edward Smith, F.R.S., secretary of the Advisory Council of the Department of Scientific and Industrial Research and secretary of the Royal Society, and on Sir J. Arthur Thomson, M.A., LL.D., emeritus professor of natural history in the University of Aberdeen.

DR. ERNST LINDELÖF, of Helsingfors, has been elected a corresponding member of the Prussian Academy of Sciences.

THE Founder's Medal of the Royal Geographical Society, London, has been awarded to Mr. Bertram S. Thomas, for his geographical work in Arabia and successful crossing of the Rub Al Khali; and the Patron's Medal to Rear Admiral Richard E. Byrd, U.S.N., for his expedition to the Antarctic and his flights over both North and South Poles.

AT a recent general meeting of the Geological Society of Vienna honorary membership was conferred on Mrs. Ogilvie-Gordon, "in recognition of her distinguished work on fossil corals, and especially in

connection with the geological structure of the Dolomites of the Southern Tirol."

THE Petrie Medal for distinguished work in archeology has been awarded to Sir Arthur Evans.

DR. CHRISTIAN RICHARD THURNWALD, of the University of Vienna, has been appointed Bishop Museum visiting professor of anthropology at Yale University. Dr. Thurnwald goes to Yale to give instruction and direct research in the problems of the Pacific area under the terms of the agreement by which Yale and the Bishop Museum of Honolulu are affiliated.

DR. HERBERT M. EVANS, of the University of California, was elected president of the American Association of Anatomists at the annual meeting which opened in Chicago on April 18, and Dr. George W. Corner, of the University of Rochester, was elected secretary. The next annual session will be held at the College of Physicians and Surgeons, New York, from March 24 to 26, 1932.

THE following officers of the American Society of Biological Chemists were elected for the year 1931–1932 at the annual meeting in Montreal on April 9: *President,* H. C. Bradley; *Vice-president,* W. M. Clark; *Secretary,* H. B. Lewis; *Treasurer,* C. H. Fiske; *Councilor,* W. C. Rose. Officers of the American Society for Experimental Pathology were elected as follows: *President,* Samuel R. Haythorn; *Vice-president,* Peyton Rous; *Secretary-Treasurer,* C. Phillip Miller, Jr.; *Councilors,* Carl V. Weller and S. Burt Wolbach.

DR. LAFAYETTE B. MENDEL, professor of physiological chemistry at Yale University, and Dr. E. B. Hart, professor of agricultural chemistry at the University of Wisconsin, have accepted appointment as advisers to the protein and nutrition division of the Bureau of Chemistry and Soils of the Department of Agriculture.

DR. J. BARTELS, professor of meteorology at the Forstliche Hochschule, Eberswalde, Germany, known for his theoretical investigations of the earth's magnetism, has been appointed a research associate in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. He took up this work on April 1. Dr. Bartels is devoting his attention principally to the interpretative discussion of the large amount of observational material accumulated by the Department of Terrestrial Magnetism.

DR. DOUGLAS W. MACOMBER, Denver, has been appointed scientific editor of *Colorado Medicine,* succeeding Dr. John Rosslyn Earp, who resigned to become director of public health of New Mexico.

DEAN ALBERT R. MANN, of the New York State College of Agriculture at Cornell University, has been elected chairman of the committee on rural and village housing, one of several groups comprising the White House Conference on Home Building and Home Ownership.

AMONG the members of the British Committee of Inquiry into Calendar Reform are the Astronomer Royal, Sir Frank Dyson; Professor Winifred Cullis, of the University of London; Sir Herbert Walker, Lord Riddell, Sir Basil Kemball-Cook, Sir Stanley Machin and Mr. A. G. Walkden, M.P.

FOR the purpose of geomorphologic field study Professor Frank J. Wright, head of the department of geology at Denison University, has obtained leave of absence for the remainder of the spring term and will accompany Professor Douglas Johnson, of Columbia University, on a trip to the Pacific Coast by way of the Gulf States. In his absence Professor Wright's work at Denison will be carried on by Professor Henry S. Sharp.

DR. JOSEPH S. CHAMBERLAIN, head of the department of chemistry at the Massachusetts Agricultural College, who has been spending a year's leave of absence at Oxford, England, and in traveling on the continent, will return to Amherst at the end of June.

THE *Journal* of the Washington Academy of Sciences reports that S. L. Seaton, former observer and radio operator on the *Carnegie,* expects to leave during the summer for the Huancayo Magnetic Observatory, Peru, to install equipment for an experimental radio station, for which an appropriation has now been made by the Carnegie Institution of Washington.

AFTER a two-year search for new varieties of soybeans in Japan, Korea and Manchuria, William J. Morse, of the Bureau of Plant Industry, has returned with a collection of about 4,000 lots of seed and more than 300 samples of products made from soybeans.

DR. WM. A. ARCHER, who resigned the position of assistant pathologist of the Plant Disease Survey, U. S. Department of Agriculture, in January, 1930, to become professor of botany and plant pathology in the Escuela de Agricultura at Medellin, Department of Antioquia, Colombia, started on April 4 on an expedition into the Intendencia of Chocó, Colombia, where he expects to spend two months collecting flowering plants, fungi and insects. His headquarters will be at Quibdo.

NINE members of the Syracuse Andean Expedition arrived in Brooklyn on April 28. The group, which was sent by Syracuse University to explore Venezuela for the Syracuse University Museum of Natural Science, left New York on December 31 last under

the leadership of Dr. Parke H. Struthers, professor of zoology at Syracuse University, and director of the Syracuse Museum. The party will bring back specimens of animal and plant life of the Andean region, as well as geographical and geological data about Venezuela. Three other members of the Syracuse University faculty returned with Dr. Struthers: Dr. Ernest Reed, professor of botany; Dr. Earl Apfel, professor of geology, and Major Sidman Poole, professor of geography.

DR. HARVEY CUSHING, Moseley professor of surgery, Harvard University Medical School, Boston, delivered the William Henry Welch Lecture at Mount Sinai Hospital, New York City, on April 30, on "The Posterior Pituitary Hormone and the Parasympathetic Nervous System." Dr. Cushing gave on April 8 the Donald C. Balfour Lecture at the University of Toronto.

DR. R. G. AITKEN, director of the Lick Observatory, gave a lecture on "Recent Progress in Astronomy" in the auditorium of the new Chemical Building of the Ohio State University, on April 22. The lecture was given under the auspices of the Perkins Observatory of Ohio Wesleyan University and the Graduate School of the Ohio State University.

PROFESSOR P. W. BRIDGMAN, of the Jefferson Physical Laboratory at Harvard University, gave the invitation address in connection with the annual initiation banquet of the Wisconsin Chapter of Sigma Xi on April 22. His subject was "Physical Effects of High Pressure." On the preceding afternoon he gave a general university lecture on "The Recent Change of Attitude toward the Law of Cause and Effect."

DR. KARL F. MEYER, professor of bacteriology and director of the Hooper Foundation for Medical Research in the University of California Medical School, San Francisco, delivered the Cutter Lectures on preventive medicine at the Harvard University Medical School on April 27 and 28. His subjects were "Botulism and Its Control"; "A Safe Milk," and "Undulant Fever in the West."

DR. GEORGE H. SHULL, professor of botany and genetics at Princeton University, recently delivered the three Luther Laflin Kellogg Lectures in biology at Rutgers University, his subject being "Evening Primroses and Evolution."

THE annual Sigma Xi lecture at the University of Oklahoma was given on April 13 by Professor C. E. Mendenhall, head of the Department of Physics of the University of Wisconsin, on "Waves and Particles." Professor Mendenhall also assisted in the ceremonies at which six members of the faculty were initiated members and thirty-two graduate students were initiated associates of Sigma Xi. On Monday he addressed the Physics Colloquium and guests on the subject, "Some Recent Developments in Photoelectricity."

PROFESSOR ELLIOT SMITH, of University College, London, lectured on April 9 in Madrid on "Prehistoric Man and the Cultural Debt of the British Isles to Spain."

THE next International Congress of Applied Mathematics will be held at Cambridge, England, in the summer of 1934.

THE American Association of Pathologists and Bacteriologists plans to hold the annual session in 1932 in Philadelphia on March 24 and 25.

Industrial and Engineering Chemistry reports that the Ninth Colloid Chemistry Symposium will be held in the Chemistry Building of the Ohio State University on June 11, 12 and 13. The university extends to the members of the symposium and their families or guests the courtesies of its dormitories from Wednesday noon, June 10, to Saturday noon, June 12. The rate, including breakfast, is $1.50 per person per day. Breakfast will be served in Pomerene Hall, a building within one to five minutes' walk of the dormitories. The reception rooms of the dormitories and the University Faculty Club will be at the disposal of the members and guests. The office of the Department of Chemistry will be the headquarters room. Those desiring to avail themselves of campus accommodations should communicate with Wallace R. Brode, Chemistry Building, The Ohio State University. All other communications relative to the symposium should be addressed to W. G. France, Local Chairman on Arrangements, Chemistry Building, The Ohio State University, Columbus, Ohio.

Nature reports that the 1932 meeting of the Iron and Steel Institute will be held in the United States of America, under the presidency of Colonel Sir Charles Wright, Bart. Arrangements, with reference to ocean and inland travel, are being made with the Institute of Metals, which is also holding a meeting in the United States in 1932. The inclusive dates for the meetings and excursions are from September 12 to September 29. Plans are under consideration for participation in some form by the Canadian Institute of Mining and Metallurgy, either at Toronto or Montreal, or both.

AT a conference of individual members of the Australian delegation to the recent Imperial Economic Conference with some of the British and the Dominion authorities concerned, it was generally agreed that the proposed meeting of the Imperial

Agricultural Research Conference in 1932 could well be postponed. That has accordingly been done, and the time of the next conference and its place are at the present time in abeyance.

HARVARD UNIVERSITY has received a favorable decision under an adjudication in the estate of Stuart Wyeth, who died on December 30, 1929, which had been contested. The court awarded the residue of the estate, about $5,528,000, to the president and fellows of Harvard University, as provided by the will, together with about $300,000 in income.

THE will of Mr. James Arthur bequeathed to the Smithsonian Institution $75,000 to establish a yearly lecture on the sun, the balance of the income to be devoted to researches relating to the sun. After compromising the interests of certain heirs, the proceeds of the bequest amount to somewhat in excess of $50,000.

WE learn from the Johns Hopkins *Alumni Magazine* that the university has received gifts for the current expenses of the department of zoology; from Mr. W. P. Eno, for the fund for the "Atlas of the Fundus Oculi"; from Mr. S. Childs, for an addition to the endowment of the Institute of the History of Medicine; from Mrs. C. H. Stout, for the "following up of toxemic patients in obstetrics"; from the National Research Council, for the support of Dr. Whitehead's studies on insulating oils; from the American Child Health Association, for the support of the work of Dr. W. W. Cort in ascariasis; from the Rockefeller Foundation, for a fellowship held by Dr. E. L. Stebbins, of the School of Hygiene and Public Health.

Nature reports that the General Board of the University of Cambridge has made the following grants from the Worts Fund: £100 to the Zoological Station at Naples: £45 to Miss W. Lamb, of Newnham College, for the continuation of her excavations at Thermi; £45 to Dr. E. B. Worthington, of Gonville and Caius College, towards the expenses of the Cambridge Expedition to the East African Lakes; £45 to Dr. L. S. B. Leakey, of St. John's College, for archeological, paleontological and geological investigations in East Africa; £45 to G. Bateson, of St. John's College, for anthropological work in New Guinea; £30 to R. T. Wade, of Clare College, towards his expenses in connection with visits to museums in Europe to study fossil fish; £20 to P. W. Richards, of Trinity College, towards the expenses of a botanical expedition to the Sierra Nevada; £15 to I. H. Cox, of Magdelene College, for geological exploration in Baffin Land.

THE American Geographical Society, Carnegie Institution of Washington, Norwegian Geophysical Institution, Woods Hole Oceanographic Institution and the Cleveland Museum of Natural History are cooperating in the preparations for scientific work to be undertaken by the Wilkins-Ellsworth Trans-Arctic Submarine Expedition.

INVESTIGATIONS of the diseases of wild life have been consolidated by the Bureau of Biological Survey under a recent authorization by the Secretary of Agriculture. Dr. J. E. Schillinger, senior veterinarian of the U. S. Biological Survey, will be in charge of the work. The object is to coordinate the study of wild-life diseases, chiefly those affecting mammals and birds, and to determine the causes of outbreaks and methods of control. Laboratories will be established in Washington, D. C., and in the field, for observation and investigation of disease-producing agents and of disease conditions among animals and birds, both in the wild and under controlled conditions, as on fur and game farms.

A FURTHER adjustment in the boundaries of the Bryce Canyon National Park, Utah, is contemplated in the passage of the recent act of the Congress approved February 17. This act authorizes the president of the United States, by proclamation, to add to the park approximately 6,360 acres of public lands containing outstanding natural features which are of greater value for scenic and scientific purposes than for economic development. The act also eliminates 1,280 acres from the national park and adds them to the adjoining Powell National Forest.

DISCUSSION

ERASMUS DARWIN AND THE BIOLOGIC CONTROL OF INSECTS

IT is commonly believed that the idea of controlling insect pests through utilization of their natural enemies is a wholly modern conception, originating in the United States. That this is not altogether true is pointed out by Wheeler, 1928, in the chapter on "Insect Parasitism" in "Foibles of Insects and Men." He says:

It is only within very recent times that what may be properly called an *economic* use has been suggested for certain parasitic and predatory insects, namely, that of controlling the insects injurious to our crops, forests, domestic animals, stored foods and fabrics. The notion of using predatory beetles in destroying garden pests seems first to have occurred to Boigiraud de Potiers in France in 1843 and in the following year to Antonio Villa, in Italy. The latter country also produced two

entomologists, Rondani and Ghilioni who, during the fifties and sixties of the past century first suggested the use of parasitic insects for similar purposes (p. 50).

It is worthy of note that Erasmus Darwin, the grandfather of the illustrious Charles Darwin, pointed out clearly the possibilities of biologic control in his "Phytologia, or the Philosophy of Agriculture and Gardening," published in London in 1800.

In the course of his very careful studies on the life history and habits of plant lice, "Most curious and important animals which may in process of time destroy the vegetable world," he did not fail to take careful account of the natural enemies. Concerning the larva of the Syrphid fly he says:

The most ingenious manner of destroying the aphis would be effected by the propagation of its greatest enemy, the larva of the aphidophorous fly of which I have given a print and which is said by Reaumur, Tom. III, Mem. 9, to deposit its eggs where the aphis abounds and that, as soon as the larvae are produced, they devour hundreds around them with no other movements but by turning to the right or left, arresting the aphis and sucking the juices. If these eggs could be collected and carefully preserved during the winter, or protected from injury in hot-houses, it is probable that this plague of the aphis might be counteracted by the natural means of devouring one insect by another; as the serpent of Moses devoured those of the magicians (p. 356).

Again, referring to the white butterflies which deposit their eggs on cabbage plants:

Cabbage caterpillars would increase in destructive numbers, but are half of them annually destroyed by a small ichneumon-fly which deposits its own eggs in their backs. . . . This ichneumon fly should therefore be encouraged if his winter habitation could be discovered.

It is not to be expected that so keen an observer would overlook the desirability of utilizing the larger natural enemies of insects.

All these noxious animals might be destroyed or diminished by encouraging the breed of small hedgebirds, and perhaps of larks, and rooks by not taking their nests. I have observed that house sparrows destroy the maychafier. . . . The various species of linnets carry small caterpillars to their gaping young.

Whatever may be our estimate of the poetic ability, or the evolutionary theories of Erasmus Darwin, he may well be proclaimed the forerunner of modern economic entomologists. He discusses methods of trapping cutworms under rubbish, tree pests by trap bands and tar-paper, collecting and burning leaves to destroy the eggs of other species. He recommends the heating of grain to destroy its insect pests without injuring its germinating quality, and using hot water or steam against others. He found that the essential oils are all deleterious to certain insects, and learned by experience that while oil of turpentine would kill aphids it also killed the branches of a nectarine tree on which he used it. Arsenic, tobacco dust and tobacco fumes he used with varying degrees of success. Especially interesting were his experiments with sulphur which he used both in fumigation and in dusting, which might be accomplished with "a powder-puff, such as hair dressers use."

Particularly interesting is the fact brought to my attention some years ago by Professor C. R. Crosby that this early worker recommended the supposedly very modern lime-sulphur mixture as an insecticide.

WILLIAM A. RILEY

UNIVERSITY FARM,
ST. PAUL, MINNESOTA

A MATHEMATICAL PROOF

IN SCIENCE for January 16, 1931, it is stated that "Tropfke in the third edition (1930) of Volume 1 of his history does not furnish proof of Professor Miller's claims" relating to Babylonian mathematics. This raises the interesting question what conditions a mathematical proof must satisfy. Such a proof seems to imply not only that the arguments are correct but also that those for whom it is intended can follow these arguments completely. For instance, I have given what seems to me to be a proof of Sylow's theorem to many classes and yet I feel utterly unable to prove this theorem to one who knows nothing about the theory of groups, and this includes the great majority of the people whom I know. Similarly, proofs relating to the history of mathematics seem to imply that those for whom they are really proofs can look up the sources and verify the statements. In this sense no one can prove to me anything relating to the ancient mathematics of the Babylonians or of the Egyptians since I am unable to read their writings and can not verify that the translations thereof are correct.

One of my most noted teachers, Professor Sophus Lie, used to tell his students that he accepted many mathematical results which he had not completely proved himself but which he believed others had fully proved. He said that he felt that he had to do this in order to make rapid progress. Similarly, I would like to think that I knew some things about the ancient mathematics of the Babylonians and the Egyptians even if I am unable to go to the sources, and references to these sources seem to me to be of value only to those who can read the original writings. In particular, I am not able to determine whether the references which Tropfke gives to the division of the circle into 360 equal parts by the later Babylonians prove

the point in question since I can not read the original, but I have confidence, perhaps undue confidence, in the truthfulness of such noted scholars notwithstanding the fact that others in whom I have less confidence have made opposite statements.

Not only does the inability to read the original frequently constitute a serious difficulty in the way of using the sources as regards historical statements in mathematics but in some cases these sources are not known to exist. For instance, the original of Euclid's "Elements" is not known to be extant and yet these "Elements" are commonly regarded as very important in the history of our subject. It seems therefore that some of the most noted mathematical historians have reached conclusions which could not have been based on a study of the original documents. It is, of course, not implied here that it is undesirable to go to the sources with respect to questions relating to the history of mathematics whenever this is possible. On the other hand, it is implied that valuable conclusions have sometimes been drawn by those who have not been in position to do this. At any rate, it is well to bear in mind that a mathematical proof depends upon the knowledge relating to the subject on the part of those for whom it is intended and hence is relative, not absolute.

G. A. MILLER

URBANA, ILLINOIS

MORE ABOUT TWISTED GRAIN IN TREES

SCIENCE for February 13, 1931, contains an article by C. K. Wentworth noting the predominance of right-handed twist in spirally grained trees. Similar observations have been recorded by others. A Forest Service official on the Pike National Forest, Colorado, reports that out of 396 alpine fir trees, 85 per cent. had right-handed twist and 14 per cent. left-handed twist, leaving only 1 per cent. with straight grain. Similarly, 26 pines showed 14 individuals with right-handed twist and 4 with left-handed twist. The author also was struck with the predominance of right-handed twist when trying to find trees with left-handed twist suitable to photograph. On the other hand, in an examination of 463 Douglas fir timbers at a mill in Tacoma, Washington, he was surprised to find 94 with left-handed twist and only 8 with right-handed twist (very slight twists not being considered). The other timbers were straight grained.

No satisfactory explanation of the cause of spiral grain has yet been made. There even remains the question as to whether it is due to heredity or environment. H. G. Champion, of the Forest Service of India, reports that seed from straight-grained trees give fewer spirally grained seedlings than seed from twisted trees. The resulting grain, however, was examined only in the young stems of seedlings, and it is not certain whether the same condition would be maintained as the trees grow older.

On the other hand, Paul van Oye reports from France that trees with tap roots have no torsion, those with lateral roots have slight torsion, and those with running roots have it to a marked degree. This corresponds to the general observation that in the higher altitudes where the soil is scant and tap roots can not develop, spiral grain is much more common than in the deeper soil at lower elevations.

The frequent deduction, as made by Wentworth, that twisted grain may be due to prevailing winds acting on asymmetrical crowns is not tenable since there is no evidence within the tree trunk that actual twisting of the trunk took place after the wood was formed. Such twisting would show distinct mechanical injury to the fibers which is not found to be the case. Furthermore, the twist would be greatest near the center and least at the periphery of the trunk, assuming that it developed gradually over a period of years. Usually the reverse is the case.

Any satisfactory explanation of the cause of spiral grain must also explain why trees should be straight grained, since whatever factors are operative in keeping the fibers of most trees parallel with the axis of the trunk are modified in producing spiral grain. To say straight grain is the normal condition is not adequate, since in some hardwood species, especially in the tropics, the normal condition is for the fibers to be inclined right-handed for a number of years, then left-handed for about the same period, and then back to right-handed, and so on.

ARTHUR KOEHLER

U. S. FOREST PRODUCTS LABORATORY,
MADISON, WISCONSIN

PUBLICATION OF INDUSTRIAL RESEARCH

THE growth of industrial research in America and the intermingling of purely utilitarian scientific work with the so-called "pure" scientific research that may be found in many industrial laboratories raise a question of vital interest in the reporting of science to the public.

Often the achievement of a new industrial process is made known to the public through the medium of a publicity statement issued by an individual or a corporation. Often these publicity statements do not have the wealth of detail that characterizes the publication of a scientific paper. The circumstances surrounding a technical development are often highly complicated. A patent may be pending. Or for other reasons the heads of the organization paying for the research do not wish to reveal the scientific and technical details of the process or the invention.

The announcement of the discovery or invention often is limited to a plain statement of claims without any explanation of how the new development has been obtained.

Notable examples in recent months include:

(1) The announcement of durium, the synthetic plastic of which the fifteen-cent "Hit of the Week" phonograph records are manufactured. The publicity on this development simply stated that a new and suitable plastic had been developed, and the materials used and the composition of the plastic were not revealed.

(2) The carbon monoxide removing attachment for automobiles developed by Dr. J. W. C. Frazer, of the Johns Hopkins University. What this device does was told in the announcement, but how it operates and the composition of the materials contained in the cannister were not made public.

(3) The development of a super-speed motion picture film by the Eastman Kodak Company. The benefits to be derived from the use of this film, soon to be placed on the market, were elaborated, but no technical information about the emulsion or the research that led to the development of this speedy emulsion could be obtained from the company even after it was pointed out that this information would be desirable.

Such instances will undoubtedly multiply in the coming months and years.

It is recognized that for the commercial protection of some of the companies supporting research there must be some instances in which it is impossible to reveal the technical details and steps of the scientific procedure that led to the discoveries and inventions being exploited commercially.

In many cases, however, lack of scientific detail is not due primarily to the fear of revelation of any material which would interfere with commercial exploitation or the obtaining of a patent. It seems to arise from the fact that many of the announcements are prepared and visaed by the sales, advertising and other purely commercial departments of the company supporting the research.

It is not proposed that the commercial side of an industry be relegated to a position of absolute subordination to the research laboratories and the scientists employed. But it is suggested that the progress of science and the understanding of science on the part of the general public will be accelerated if scientists in industrial work will insist, so far as possible, that publicity reports of their work be as carefully prepared and as revealing as reports intended for publication in scientific and engineering journals.

WATSON DAVIS

SCIENCE SERVICE

THE LIFE OF BOOKS

[Apropos of the reference to "Life of Books" in SCIENCE, Feb. 27.]

THIS has long been a subject of great concern to librarians, under our present system of heating, the most of which is unhygienic, as practicing physicians and others will confirm, from the time of Franklin.

The disintegration of bindings I find largely confined to leather, particularly the Russian leather type. There is, however, in my library a wonderfully preserved volume, bound in human skin, in 1861—the skin from a soldier who died in the Civil War. This has completely resisted the effect of both the steam and hot water system of heating, and is in as perfect condition to-day as when bound in '61.

In a voluminous scientific correspondence which covers the period 1838–1891, the only writing paper which shows disintegration in the whole series of letters is the blue paper used by the Smithsonian Institution, principally letters of Joseph Henry and Spencer F. Baird during the 50's and 60's of the last century.

JOSEPH LEIDY II

REPORTS

THE MILTON AND CLARK AWARDS AT HARVARD UNIVERSITY

AWARDS amounting to more than $60,000 have been made from the Milton and Clark Funds to members of the teaching staff of Harvard University to enable them to carry on research during the academic year 1931–32. The following list contains the names of those to whom the awards in the physical and biological sciences have been made and a statement of the purposes for which the grants will be used.

Henry E. Bent, instructor in chemistry, for study of the electron affinity of a number of organic free radicals in order to obtain quantitative data relative to the valence of carbon.

Raoul Blanchard, professor of geography, for continued geographical exploration field-work along the north shore of the St. Lawrence estuary from Quebec to the Strait of Belleisle.

Nicholai A. Borodin, curator of fishes, for study of the "Anabiosis" or the phenomenon of resuscitation of fishes after being frozen.

Paul E. Boyle, instructor in operative dentistry, for study of the circulation of the dental pulp.

William J. Clench, lecturer on zoology, to collect

in the Florida Everglades the highly specialized molluscan fauna modified to live in the trees of the isolated hammocks.

Lemuel R. Cleveland, assistant professor of protozoology, for study of the wood-feeding roach, *Cryptocercus punctulatus* Scudder.

Carleton S. Coon, associate in anthropology, for rewriting and bringing up to date Ripley's "Races of Europe."

Reginald A. Daly, Sturgis Hooper professor of geology, Kirtley F. Mather, professor of geology, Donald H. McLaughlin, professor of mining engineering, and L. Don Leet, instructor in seismology, for study to determine the elastic constants of rocks for the Quincy and Westerly granites by measuring the velocity of transmission of vibrations from dynamite blasts.

Walter F. Dearborn, professor of education, for the construction of a stereoscopic optometer to study differences in the eyes of school children who have difficulty in learning to read.

Merritt L. Fernald, Fisher professor of natural history, to map the ranges of living plants as important checks on historical geology.

Willard J. Fisher, lecturer on astronomy, and Harlow Shapley, Paine professor of practical astronomy, to help finance a scientific investigation of meteors in Arizona.

Edward W. Forbes, director of the Fogg Art Museum, to develop a technique for the transference of Asiatic wall paintings and study the properties and application of varnishes and other protective coatings as a means of preservation.

Russell Gibson, instructor in geology, to correlate a series of sedimentary rocks in the Northwest, determine the relationship of certain intrusive igneous rocks to the central Idaho intrusive, determine the origin of the ore deposits, and discover the extent of glaciation and the possible modification of the gold-bearing stream gravels by glaciers.

Louis C. Graton, professor of mining geology, to build a precision photographic microscope for the study of "opaque" materials by polarized light.

George B. Kistiakowsky, assistant professor of chemistry, to study the oxidation of gaseous hydrocarbons, particularly the oxidation of acetylene, so as to derive a kinetic interpretation.

Alexander McAdie, Abbott Lawrence Rotch professor of meteorology and director of the Blue Hill Observatory, for the further development and installation of a thermodynamic thermometer.

Henry A. Murray, Jr., assistant professor of abnormal and dynamic psychology, to study the psychology of humor, and the relationship between certain psychological and physiological processes.

Ralph B. Perry, Edgar Pierce professor of philosophy, to record the thought and character of William James, as revealed in unpublished correspondence, notes and marginalia.

Gregory Pincus, instructor in general physiology, to investigate the nature of the development of the temperature-regulating mechanism in mice, and record the various interrelated phenomena.

Percy E. Raymond, professor of paleontology, to study Paleozoic myriapods and Paleozoic crustaceans, other than trilobites, in England, Scotland and Ireland.

Lawrence D. Redway, associate in anthropology, to initiate investigation looking toward the creation of a new and accurate color scale for the anthropologic classification of eye structure and pigments by means of color photography.

Albert Sauveur, Gordon McKay professor of metallurgy and metallography, to purchase a Southwark 60,000-pound Universal testing machine.

Marshall H. Stone, assistant professor of mathematics, for expenses incurred in preparing for publication a manuscript on "Linear Transformations in Hilbert Space."

Morgan Upton, instructor in physiology and in psychology, for investigating temperature changes in active nerve tissue at the laboratory of Professor A. V. Hill in London.

Robert DeC. Ward, professor of climatology, to prepare for publication data on the climatology of the United States, Mexico and the West Indies, as a contribution to a new *Handbuch der Klimatologie.*

Ralph H. Wetmore, assistant professor of botany, to make collections in Panama to facilitate the further study of phylogeny in the angiosperms.

Robert H. Woodworth, instructor in botany, to investigate the origin and development of vessels in seed plants as bearing on the question of phylogeny of plant groups.

Jeffries Wyman, Jr., instructor in zoology, to study the dielectric properties of amino acids and proteins.

The Milton Fund, created by the will of William F. Milton, '58, came into the possession of the university in 1924. Under the terms of that bequest, the income must be used "in the interests of, or for promoting, the physical and material welfare and prosperity of the human race, or to assist in the discovery and perfecting of any special means of alleviating or curing human disease, or to investigate and determine the value or importance of any discovery or invention."

This is the first year in which grants from the Clark Fund have been available. It is founded on a bequest from Joseph H. Clark, '57, who provided that "the income shall be devoted to the encouragement and advancement of original research."

Dr. Frank B. Jewett, electrical engineer, of New York City, and Professor Edwin F. Gay and Professor William M. Wheeler, both of Harvard, make up the committee to advise the president and fellows in selecting purposes for which grants are made.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFIED FORM OF KUNDT'S TUBE

In this form of Kundt's tube the air column is set in vibration by a reed from a mouth organ; the reed being actuated by a blast of air. The cork to which the reed is attached is moved back and forth in the glass tube by means of a hollow brass rod which also conducts the compressed air to the reed. At the nodes the vibration of the reed is dampened while

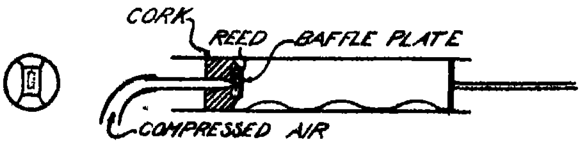


Fig. 1

at the loops, the intensity increases greatly. Thus a large class can listen to the change in intensity. The shadows of the cork particles in vibration may also be projected upon a screen. The success of this instrument is due to the introduction of a baffle plate in front of the reed by Lee Fullmer of our laboratory. This leaves two small rectangular openings in front of the reed, which are actually the sources of the vibrations transmitted to the air column. Therefore as the reed is moved back and forth it never quite ceases its vibration as it would do if unprotected. The cork which holds the reed fits loosely in the glass tube so that air escapes past it when the compressed air is turned on.

R. C. Colwell

Department of Physics,
West Virginia University

AN INEXPENSIVE GLASS MARKING PENCIL

A very satisfactory substitute for the diamond pencil generally used for marking glassware may be easily made from an ordinary file. A six-inch round file is most convenient, but the triangular variety will serve. To make the pencil, the tang of the file is broken off, and the large end of the body is ground to a point. It is then heated to a bright red, and rehardened by plunging into mercury. Triangular points with sharply cut facets have given the best results of the various styles tried. Round points require heavier pressure for marking and appear to be less durable. It is important that the slope be rather short and that the angle between facets at the point be not less than ninety degrees. Long sloping needle-like points have a gouging action that makes neat marking impossible. About an inch of the file should be heated in a Fisher burner, and the cutting point should be kept out of the flame till the portion back of it is red-hot. The hardening operation is best done in a hood to avoid danger of inhaling mercury vapor. A pyrex test-tube is convenient for holding the mercury, and if a number of the pencils are being made, it may be placed in a water or ice bath.

The writer has tested a number of these markers in comparison with a splint diamond and one of the new tungsten carbide pencils, and has found them entirely satisfactory. It is to be expected that the steel pencils will be less durable than the diamond or the tungsten carbide markers, but they will apparently outlast the ordinary carborundum point. One of them has been used for making over five hundred single letters or figures without marked evidence of wear, while another which was not retempered but was ground carefully to maintain the hardness of the file made barely a dozen. The cost is but a fraction of the usual price for the other pencils, and a worn point can be resharpened or a new one made in about ten minutes.

Charles B. DeWitt

University of Tennessee

SPECIAL ARTICLES

THE EFFECTS OF ULTRA-VIOLET LIGHT ON PARAMAECIUM

Probably one of the most interesting problems which has ever presented itself to the physicist and the biologist alike is the effect of ultra-violet light on organisms of all kinds. Little effort seems to have been directed, however, on the well-known infusoria *Paramaecium*. In a series of experiments recently performed by the writer a number of interesting phenomena were observed.

The source of light was a one and a quarter ampere mercury vapor arc lamp with a corex glass bulb containing a window less than two one-thousandths of an inch in thickness. The ultra-violet obtained had a wave length of from 2,500 to 3,650 angstrom units. There was a little visible light given off but practically no heat. The *Paramaecium* were placed in a cavity slide with the water about two millimeters thick and at a distance of about two inches from the window of the tube so that they could be watched through the microscope during the exposures. The following results were noted:

(1) The *Paramaecium* becomes shorter and much thicker. After about half a minute of irradiation under these conditions a limit is reached at which time the *Paramaecium* is about three quarters its original length, the diameter being larger as a result.

(2) The cell wall is shown to be composed of at least two layers which separate to form a sort of blister. This took about one and a half minutes' total exposure. That there is a distinct cell wall between the blister and the interior of the *Paramaecium* may be shown by the fact that the cytoplasm can be seen entering the blisters which before were quite clear and free of all matter.

(3) The proteins of the cytoplasm coagulate. Thus the food vacuoles and contractile vacuoles, etc., which were clear and sharp, become indistinct and undifferentiated.

(4) The outer wall finally breaks, letting the coagulated cytoplasm into the surrounding liquid where it disintegrates.

(5) Perhaps of most interest, the *Paramaecium* fluoresce a pale violet color when living but seem to lose this property when dead. This may best be seen when the field is illuminated with a yellow light at the same time that the ultra-violet is turned on the *Paramaecium.*

(6) After having been exposed for about half a minute, although the *Paramaecium* do not die immediately, they will not live more than two or three hours and will never divide or continue growth—due probably to the fact that the life processes are stopped by the coagulation. It was found that specimens which had partly divided by simple fission stopped at whatever stage they were and died several hours later having been exposed for only half a minute.

(7) Most of the specimens threw out a tremendous number of trichocysts.

L. B. RENTSCHLER

PRINCETON UNIVERSITY

THE NORTH AMERICAN LUNG FLUKE

ALTHOUGH the lung fluke, *Paragonimus*, has been reported from cats, dogs and pigs in this country since 1894 the life history, until the present time, has been unknown. In the course of studies on the parasites of our native mink, *Lutreola vison*, it was found that this fluke is not uncommon and at the suggestion of Dr. W. A. Riley a study of the life history was begun.

A wide variety of aquatic animals serving as food for mink was taken into consideration, but since various species of fresh water crabs and crayfish act as an intermediate host of the Asiatic lung fluke, *P. westermanni,* particular attention was devoted to the native *Astacidae.* These were often found to harbor immature flukes and during the summer of 1930 a single specimen, regarded as possibly *Paragonimus,* was found in a *Cambarus* from a small creek near Minneapolis. On November 11, 1930, large numbers of distome metacercariae agreeing closely with Kobayashi's[1] description of those of the Asiatic lung fluke were found in *Cambarus immunis spinirostris*[2] from the same creek. Since then particular attention has been devoted to these larval forms.

The cysts are spherical and transparent, measuring 2.5 mm to 5 mm in diameter. The enclosed larvae are sometimes folded and sometimes straight. When excysted their length varies from 0.5 mm to 2 mm depending on the degree of contraction. They are covered with minute spines and each possesses a large boring spine on the dorsal side of the oral sucker. The intestinal rami are striking in their similarity to the large convoluted rami of the adult *Paragonimus.* The excretory bladder is a large, conspicuous, unbranched sac extending anterior to the acetabulum and filled with highly refractive globules. A short distance posterior to the acetabulum two small ducts extend laterad from the bladder, each one bifurcating into an anterior and a posterior branch. The characteristic red color noted for the metacercariae of *P. westermanni* is lacking.

Thirty-two per cent. of the crayfish examined from the creek in question were infected. The cysts varied in number from 1 to 8 and without exception were found in the pericardial cavity.

These cysts were fed to two cats, the first cat receiving 35 between November 13 and 17, and the second receiving 30 between November 25 and 27. The animals used were reared on the experimental ranch of a commercial animal food company and had no access to aquatic animals. In the laboratory they were fed a commercial preparation, milk and liver. Frequent fecal examinations over a period of six

[1] Kobayashi, Harujiro, "Studies on the Lung Fluke in Korea. I. On the Life History and Morphology of the Lung Fluke," Mitt. Med. Fachschule zu keijo, 97–115, 1918.

[2] The writer is indebted to Dr. Samuel Eddy for the identification of this crayfish.

months had shown light roundworm infections but no trematodes.

January 5, 1931, both cats were coughing badly and eggs of *Paragonimus* were found in the feces of the one first fed. The second and apparently more severely affected animal was killed. Examination revealed 24 young flukes, measuring from 4 to 6 mm in length, encysted in pairs in the lungs. Although no eggs were yet being produced, stained and cleared specimens left no doubt as to their being *Paragonimus kellicotti*.

It is thus evident that at least one species of our native crayfish serves as second intermediate host of the lung fluke. Further studies on the life history and significance of the parasite in North America are being undertaken as a cooperative project of the departments of zoology and of entomology and economic zoology at the University of Minnesota.

FRANKLIN GERHARD WALLACE
UNIVERSITY OF MINNESOTA

A PRELIMINARY NOTE ON THE OCCURRENCE OF A COLOR MUTATION IN THE HOUSE MOUSE (MUS MUSCULUS)

THE known genes of the mouse, *Mus musculus*, are more numerous than those of any other member of the rodent order, although there are still several known genes in other species of rodents which have not as yet been observed to mutate in mice. Animal experimenters are continuously on the watch for inherited variations in any of the visible characters of their stocks, and, since the occurrence of detectable mutations is rare in mammals, it is of interest to find a color character in a highly inbred strain of mice which has not, to our knowledge, occurred before.

This inbred strain of control animals has been produced in these laboratories by progressive matings from one pair of animals. The present stock is made up of animals which have been bred by brother-sister, or back-cross to father, matings and are now 20 or more generations removed from the original parent animals. The genetic constitution of this strain is given as aabbCCDDPP, etc., by the symbols of the American Mouse Club. Phenotypically these animals have a chocolate brown coat which is solid except for an irregularly occurring white patch on the ventral surface of the trunk or on the tail.

In the later part of August, 1930, two color mutants were observed among the progeny of these chocolate brown mice. The mother of these animals, ♀10367, had been mated to her brother, ♂10368. A sister, ♀10366, produced a litter by the same male in which there were four phenotypically normal animals. Three of these young (♀11045, ♀11044 and ♂11042) were mated brother to sister.

In October female 11045 gave birth to a litter of four young, two of which were apparently identical in color with the previously observed mutants.

The chocolate brown strain of mice from which these animals have appeared has bred true to color since its origin from heterozygous black (Bb x Bb) parentage 20 generations previous to the present occurrence. The new mutant animals resemble somewhat the dilute brown mice (ddbbaa) which are a familiar laboratory strain. They are of a lighter shade than these animals, the lightness being pronounced on the ventral surface of the body and around the head. No difficulty is encountered in distinguishing the mutants from the ddbbaa animals.

The mutant animals are fertile and breed true. The new color character has been tested and found not to be in the Dd (intense, dilution) or the C c^{ch} c^{d} c (color, chincilla, extreme dilution, albino) allelomorphic groups, and is recessive to the presence of chocolate brown.

The character is being tested and will be reported more fully.

JOSEPH M. MURRAY
ROSCOE B. JACKSON MEMORIAL LABORATORY

BOOKS RECEIVED

BRADLEY, J. CHESTER. *A Manual of the Genera of Beetles of America North of Mexico.* Pp. x + 360. Plates. Daw, Ilston.

CLARK, AUSTIN HOBART. *A Monograph of the Existing Crinoids. The Comatulids. Volume I, Part 3.* Bulletin of the U. S. National Museum, Smithsonian Institution, No. 82. Pp. vii + 816. Plates. Government Printing Office. $2.00.

JEFFREYS, HAROLD. *Scientific Inference.* Pp. vi + 247. Cambridge University Press, Macmillan. $3.25.

KEYSER, CASSIUS J. *Humanism and Science.* Pp. xx + 243. Columbia University Press. $3.00.

National Research Council. Bulletin No. 77. Physics of the Earth—Volcanology. Pp. vii + 77. *Bulletin No. 78. Physics of the Earth—II—The Figure of the Earth.* Pp. iv + 286. *Bulletin No. 79. Physics of the Earth—III—Meteorology.* Pp. xi + 289. National Academy of Sciences.

PATTEN, BRADLEY M. *The Embryology of the Pig.* Second edition. Pp. x + 327. 168 figures. Blakiston. $3.50.

SHERMAN, H. C., and S. L. SMITH. *The Vitamins.* Pp. 575. American Chemical Society Monograph Series. Chemical Catalog Company. $6.00.

WOODWORTH, ROBERT S. *Contemporary Schools of Psychology.* Pp. vi. + 232. Ronald Press. $2.50.

Errata: Dr. Karl Landsteiner requests that the following corrections be made to his article appearing in the issue of SCIENCE for April 17:

Page 406, first column, line 7: In place of "isoantibodies," read "immune isoantibodies."

Page 408, second column, line 4: In place of "tumors," read "ulcers."

Page 409, first column, line 7: In place of "which," read "who."

Page 409, second column, line 7: In place of "protein," read "proteins."

SCIENCE

Vol. 73 — Friday, May 8, 1931 — No. 1897

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

TECHNOLOGY AND MATERIAL PROGRESS[1]

By Dr. WILLIS R. WHITNEY

DIRECTOR OF RESEARCH LABORATORY, GENERAL ELECTRIC COMPANY, SCHENECTADY

There is nothing in fixity. It is a figment of the imagination. The fact is old, the discovery is modern. Progress and not product dominates mankind. This has always been a changing universe. Perhaps the cave-man noted no change, but nevertheless its continuity had already been long established. Nowhere in the widest stretches of astronomical time is there any sign of one changeless period. The starry firmament itself has only been known to us through its changes. We interpret rays from the stars as proof that the most stable things on earth, our very elements, are being reduced and produced. The atoms are wireless stations which broadcast information of changes quite beyond our earlier comprehension.

Continuous change marks not only celestial systems and our inorganic worlds, but every living thing, from polyp to politician. All have developed by change and are still changing.

The single living cell which first slipped the hawser that anchored it to some submarine rock hopefully wiggled its residual stump, or cilium, and, thus experimentally moving about, found it could better meet its food half way. Thus changes for good in life may be due to an unsatisfied, but not necessarily dissatisfied previous state. Being unsatisfied or inquisitive is not safety first, and in the Devonian age many an experimenting fish must have died at low tide before satisfactory lungs were developed.

Certainly the persistence of change, the absence of fixity which is so evident to-day, must have been seen by early philosophers, though I suspect that the possibilities in change, nay, the certainty that changing, or progress, is the all-important thing, had not been

[1] Presented at the general meeting of the American Philosophical Society, Philadelphia, April 23, in the symposium on "Tendencies in the Natural Sciences in the Changing World."

discovered at the time of Socrates. I find him saying in Plato's "Republic" something which is not further expanded. In considering the possible source or training of leaders for the republic, Socrates asks briefly, "What sort of knowledge is there which would draw the soul from *becoming* to *being?*" I am supported by Jowett's notes on the "Republic," which contain this significant reference: "The regular *growth* of a state enlightened by *experience, progressing* in knowledge, improving in the arts of which the citizens were *educated* by the fulfilment of political duties, appears never to have come within the range of their hopes and aspirations."

Our knowledge of nature's laws is always incomplete and ragged. Man-made laws are imperfect and inconclusive. The edges of all human fabrics are rough and frayed. Our inventions and devices are like little islands rising from an infinite ocean, or like living trees in fertile fields growing at all exposed surfaces. All sciences are adding new science at the tips of countless branches to-day, and must always do so. This fact in turn becomes a necessary and inseparable part of our technology and material progress.

Once the men of every race were less appreciative of their possibilities of change and more deferential to powers in lower animals. Every country, every tribe and almost every family at one time adopted, and even worshipped, some lower animal. So we have the American Eagle, the Russian Bear, the British Lion, the Mohawk Turtle, the Egyptian Scarab, the Chinese Dragon, etc. Francis Bacon attributed to Herodotus the view that the Egyptians deified many animals because they were so much better discoverers and inventors than men. It is as though inquisitive change was recognized in lower animals long before man saw any direct possibilities in discovery for himself.

In some respects, the beginning of advancement of science might be attributed to the twelfth and thirteenth centuries. At that time (or even earlier), foreign students in European cities, living abroad to acquire new knowledge in medicine, religion, civil customs, etc., were forced to protect themselves by forming organizations which became the universities. This process of international spread of knowledge has never been reduced, and some of our modern physical, chemical and mechanical processes and products are directly traced to researches in pure science, carried out entirely under university auspices. In other words, it was through the efforts of ancient organizations, themselves changing or progressing, that the scientific foundations were laid for our material as well as our spiritual progress. The process has become continuous and at no time has there been absence of a spiritual aim.

Having the possibilities of infinite change in mind, Bacon in 1600 wrote powerfully against the inactivity of men who were limited by fear and superstition, taboos and cumbersome words.

A change did, indeed, begin about this time. Men were encouraged to seek freedom from false gods, from mysterious words, from ancient traditions; unprejudiced attack by experiment and observation was suggested, and means for improved communication, for economical recording and preserving of truth were devised. Cheap printing was in vogue.

From then on even those institutions of highest religious aim turned gradually toward considering the lily, and to diligently questioning and enjoying study of the rest of the universe. Galileo and the first scientific society date about 1600. The British Royal Society (1662), the French Academy of Sciences (1666), the Berlin Academy (1700), and the American Philosophical Society (1769) followed this great change. Gradually the universities all over the world began devoting effort to progress in new knowledge. Not satisfied to be mere preservers or storehouses of collected wisdom, they learned by experiment and saw that there never need be a limit to advancement of knowledge. Its acquirement by direct attack soon took place in countless different directions, and in all civilized countries, and the whole orderly product received the title of "science." It is having such a broad influence that we need not expect man to move in cycles or circles. He is progressing rather in an ascending helix.

Without delving deeply into technology and material progress, I wish to introduce a few specific instances of this early perception. I have enjoyed noting the various ways in which men first commenced to express faith in progress. No other animal does it.

I like to think of pious old John Woolman, who would not allow his clothing business to expand lest it interfere with his spiritual growth, as being appreciative of progress. He believed it possible to "provide all men with an environment which will best develop their physical, mental and spiritual powers." This was not mere theory with him, for he sought to apply it when he helped prepare the way for changed treatment of the American Indians, and, over a century before the Civil War, fought earnestly for the freedom of the slaves.

Baron de Tocqueville, writing of the Americans in 1850, said:

> They have all a lively faith in the perfectability of man; they judge that the diffusion of knowledge must necessarily be advantageous and the consequences of ignorance fatal. They all consider society as a body in a state of *improvement*, humanity as a changing scene in which nothing is or ought to be permanent, and

they admit that what appears to them to-day to be good may be superseded by something better to-morrow.

He adds, cautiously, "I do not give all these opinions as true, but as American opinions."

Bearing on de Tocqueville's remarks, Mr. M. E. Tracy recently wrote in the *World Telegram:*

To a great extent, we Americans have cultivated an insatiable thirst for change and innovation. We want nothing so badly as new methods and new devices. We are intrigued by nothing more distinctly than the thought that there is bound to be something different just around the corner. The appetite for experiment, discovery and invention is in our blood.

Modern philosophers, like Bergson and John Dewey, have advanced about as far as people are yet willing to follow in this view of progress. It is a bit novel to think of the process of change as more important than any finished product. We have naturally a thought of the importance of arrival, the imminence of the millennium. But arrivals are only rising steps of immortal growth where the worth-while thing is climbing, not resting. Bergson, in Creative Evolution, says, "We change without ceasing. To exist is to change, to change is to mature. Duration means invention, the creation of forms, the continual elaboration of the absolutely new." There is no sign of fixed states here.

John Dewey has said, "The vanity and irresponsibility of values that are merely *final* and not also, in turn, means to the enrichment of other occupations of life ought to be obvious." The process of growth, of improvement and progress rather than the static outcome and result become the significant thing. "Growth itself is the only moral end." "Not perfection as a final goal, but the ever-enduring process of perfecting, maturing, refining, is the aim of living."

In 1895 Professor William James heard a Harvard teacher say, "All the fundamental conceptions of truth have been found by science, and the future has only the details of the picture to fill in." Professor Wilhelm Ostwald had just expressed the same thought in Leipzig. James vigorously denied this theme and said truly, "Our science is a drop, our ignorance a sea." Since 1895, radium and the x-ray have been developed, the atom broken down, the electron discovered, Einstein's generalization produced, the quantum conception provided. Our bones are now made visible, we communicate with Europe by radio, television is in sight, aeroplanes have become common, and we admit that we know less about the essence of time, space, gravitation and light than was known in '95. Truly our ignorance is a sea, our knowledge almost an evaporating drop. But the fortunate thing is that we are still changing.

We see new industrial experiments carried on all around us, but do we realize that they constitute progress, and that this is more than ever possible through the magnitude of the experiments and the facility with which they are made public? From the remote concentration of human physical efforts in Russia and the unprecedented trials in England's dole, to our own internal novelties in the way of unemployment relief and veterans' bonus loans, the world is trying changes. And it is too early to compare with certainty the effect of the underpayment of the one with that of the overpayment of the others.

Our international technical possibilities are like the sinews of the child, not easily broken, but not yet tested or developed. We use radio for mere amusement and noisy advertising, our wealth for armies and schemes for destroying our neighbors. We can not change at once, but we realize that there is a gradual tendency to get together and to live in peace.

Count Keyserling, in his Paris lectures on the domination of the machine age, looks at our present civilization in the United States as the "tragic misconception of the modern epoch traceable to a failure to recognize that man is essentially spiritual." He may be right. But all former civilizations were still more tragic misconceptions, if knowledge and truth are criteria. There has never before been a time when a man, speaking on the banks of the Seine, was heard in the reaches of the Trocadero through mechanical amplifiers, and his words published all over the world on the following morning. In fact, if the spiritual leadership of such a man were evident even to a very small number of his fellows, his voice could be instantly broadcast to the world by devices which mark, as plainly as anything does, our machine age.

The speed with which we are applying new knowledge seems dangerously rapid to some, but there is every indication that it will not be reduced. An individual, or a nation, may decide that it has experienced a too rapid mechanical progress, but, as long as others advance, there will be an increasing tendency to bring all people to whatever has apparently (at least temporarily) proved to be the most satisfactory condition. In other words, it has always been, and probably will always be, a changing scene, with new experiments pointing a way to better conditions.

There never was a time when so many people in one nation, or so many nations of the world, were trying to advance. There never was a time when technical and material progress was more constructively attempted and critically examined. There never was a time when any one's efforts for good were so quickly and so generally broadcast. There never was a time when youth was more earnest or fearless in seeking the essentials of truth. The accumulated data of all material progress never were so great and never so

uniformly appreciated. If one country slackens in gaining new knowledge, the whole world knows it at once. If another country, or even any individual in it, advances the science of some particular field but a trifle, the rest of the world begins at once to use it. Pavloff's experiments in Leningrad on salivating dogs are quickly coordinated with psychological researches in America, and these in turn with brain mechanics, and then operators in highly mechanized manufacturing plants are experimentally chosen, graded or discharged according to reflexes and psychological reactions.

Those who are interested in technical progress look at it as continuous, but do not necessarily overrate its importance. There must be a parallel advance for the higher values in man. Perhaps the best way to look at our materialism is just as we now look at its earliest examples, for we are but a very short way from what may be called our real beginning as thinkers.

All the early discoveries which first insured bare preservation through continued effort were augmented by technical discoveries like tool making, food growing, fire building and animal control. These in turn were followed by time-saving and time-integrating developments like writing and printing. Our present accessories in electricity, mechanics and electronics, important because of proximity, are only the latest added steps, not the last. They lead to new kinds of people with new kinds of minds. This is what man at every previous stage has devoutly sought for, earnestly fought for and generally acquired.

There are errors in scientific conclusions now, just as there have been in the past. Hardly a single scientific fact of one century remains adequate for the next. First the world is flat and the sun rises; then the world is round and the world goes around the sun. Then the whole system moves through infinite space towards Alpha Centauri, and then the space loses its infinite quality and adds a curvature. I don't expect to see the end of changes, nor will any one else, because the last man will insist on making them while he improves. Our conceptions, discoveries and uses of an unfathomable universe are certainly always flexible and subject to improvement.

I think the world is more anxious to go right than ever. It is more eager to develop intelligently and not stop at some temporarily agreeable state. It is learning that any conceivable fixed state is not worth while so long as we still possess the power to advance.

It is futile to expect a world which is already enlightened to the advantages of material knowledge, mechanical substitutes for physical labor, and the promise of freedom for better growth in the future, to reduce its efforts or change its direction.

Man *is* essentially spiritual, but his tokens of values, his media of exchange, the flowers of goodwill to others, call for material (even mechanical) devices. The Greek slave, the Egyptian fellah and the man-with-the-hoe developed into the modern, less-enslaved philosopher who sees that man is essentially spiritual. If there is one thing modern mechanical civilization can do, it is to free people from slavery and strew spiritual opportunity along their path.

OBITUARY

EARL DOUGLASS

MY good friend and coworker in paleontology, Mr. Earl Douglass, died Tuesday, January 13, 1931, in a hospital at Salt Lake City, Utah, following an operation due to an attack of influenza, and other complications. Mr. Douglass had not been in good health for a number of months, in fact he was not in robust health last October when I last saw him at his home in Salt Lake City. However, the sudden and critical turn to his illness came as a distinct shock to his family, his many friends and colleagues.

Mr. Douglass was born in Medford, Minnesota, October 28, 1862, the son of Fernando and Abigail Louisa Douglass. He studied in the University of South Dakota, in 1888, and later took his Bachelor of Science degree at the Iowa State College, Ames. He studied in the Agricultural College and Missouri Botanical Gardens, St. Louis, and attended the University of Montana, where he took his master's degree. From 1899 to 1900 he taught geology, physical geography and physics at the University of Montana. From 1900 to 1902 he had a fellowship at Princeton University under Professor W. B. Scott.

In 1902 Mr. Douglass joined the staff of the paleontological section of the Carnegie Museum. At this time began my acquaintance and pleasant association with him, which continued uninterruptedly for nearly thirty years. His life was exemplified by conscientious and diligent work in all his undertakings, which was but slightly rewarded.

Mr. Douglass married in October, 1905, Pearl C. Goetschius, of Alder, Montana. One son, Gavin Earl Douglass, was born of this union.

Mr. Douglass's most famous field work was in connection with the Carnegie Museum when he discovered in 1909, and continued work for twelve or thirteen years in, the Jensen Fossil Dinosaur Quarry on Green River, northeast Utah. This quarry was finally taken over by the United States Government and set aside as a national monument. After this the quarry was

called the National Dinosaur Monument Quarry, without question the most famous dinosaur quarry in the world.

In 1924 Mr. Douglass joined the University of Utah and assisted in preparing dinosaur material, which he obtained from the famous Jensen quarry after leaving the Carnegie Museum in 1924.

Among the activities by Mr. Douglass the last year or two of his life may be mentioned his preparation of an exhaustive geological survey of the Barbour Asphaltum Company holdings of the hydrocarbon deposits in the Uinta Basin, Utah.

Mr. Douglass's activity in research was quite extensive. Besides many publications on economic geology and other subjects in various periodicals not easily accessible or even listed, there are some twenty-four titles recorded in the catalogue of the fossil vertebrates of North America by Dr. Oliver P. Hay.

O. A. Peterson

Carnegie Museum,
Pittsburgh, Pennsylvania

ERIK EKMAN—AN APPRECIATION

The work of Erik Ekman as a botanist has been most competently recorded by a fellow botanist in a recent number of Science, and to that account I have nothing to add. It is rather to emphasize his unique character as a man and as an individual that a mere entomologist can hope to speak. A trained writer, such as Seabrook in his "The Magic Island," can give a not inaccurate account of how Ekman appeared to ordinary persons; yet without some knowledge of the fundamental impulses actuating his conduct and his outwardly unkempt mode of living, true appreciation of his character is lacking.

In considering the historic figures who, in pursuit of a great purpose, have given up all thought of family and friends, wealth and position, worldly honors and distinctions, one should not forget the conflict in interests before the decision was made to forsake them all. Yet so far as one could judge of Ekman, there was no conflict, and never had been. He lived wholly and absolutely for botany, without thought of other considerations. When he importuned transportation to go on an extended field trip, there was nothing personal about his request. The mode of transportation and physical discomfort meant nothing, if only one would stop and let him observe and collect long enough at the desired localities. A fellow botanist, H. D. Barker, one of whose ambitions had long been to own and drive a Cadillac, took the two of us on a long trip across the border into the Dominican Republic, my own humble function being to hold tight and read the speedometer when Barker was fully occupied in getting 65, 70 and 72 miles an hour out of the venerable bus. At one point Ekman decided that a certain cactus might be sub-specifically different from that growing elsewhere in Hispaniola, and, to determine the point, he collected an abundance of material, which for safe-keeping was placed loosely in the back of the car, under his knees. For ordinary travel this was well enough, but when Barker really began to push the car over rough roads, Ekman yelled that the cacti were pricking him. No wonder, yet it never occurred to him to throw them out until two or three days later, when they could be compared with other material and the point at issue regarding their difference or identity definitely settled.

Travel by private automobile, however, was really exceptional for Ekman. He usually walked. Unhesitatingly, he often started out afoot on trips that would last for weeks, especially to the more inaccessible parts of the island. At times he was nearly barefoot because he had worn out the soles of his shoes. Never did he complain at what food and shelter for the night the humblest and poorest Haitian peasant could furnish.

But little as physical discomfort meant to him, even less did the opinions of others affect the mental atmosphere in which he dwelt. The thick-skinned pertinacity of a "go-getter" salesman was as nothing compared with the indifference of Ekman to what those who were helping him collect might think of him personally, or of his activities. Of course he might have smoothed his way of being less direct and outspoken in his statements of fact or opinion, but even such slight deviations from his singleness of purpose were not considered. Systematic botany was a wholly sufficient end, which must excuse any breach of ordinary etiquette by its devotees. My own requests for identification of the host plants eaten or infested by insects were always treated as only parasitic, and entirely accidental, by-products of a science complete in itself, while more obviously practical applications of his knowledge were hardly worthy of discussion.

No account of Ekman in Haiti is complete without mention of the sympathetic aid given by the kindly, white-haired German pharmacist, Buch, who took Ekman into his own household, cut a previously unnecessary window in a partition of an upper floor of his store, and fitted up a room where Ekman could work undisturbed and keep his material. At times when Ekman tended to devote too much time to field work, Mr. Buch insisted that he keep his herbarium in shape and continue to forward his material to Germany for more intensive study, comparison and description. Without some such quiet, self-effacing, appreciative person to organize Ekman's exceptional abilities, a large part of the tangible results accruing from his enthusiasms in toiling with heavy herbarium presses in the baking heat of Haitian deserts or in

the chill of rain-drenched mountain peaks would have been lost to science.

GEORGE N. WOLCOTT

ISABELLA SUBSTATION,
PORTO RICO

RECENT DEATHS

PROFESSOR GEORGE HERBERT MEAD, since 1894 connected with the University of Chicago, since 1907 as professor of philosophy, has died at the age of sixty-eight years.

THOMAS TARVIN GRAY, president of the Gray Laboratories of Newark, New Jersey, and well known as a consulting petroleum technologist, died on April 27. He was forty-nine years old.

DR. WILLIAM A. DRUSHEL, teacher of chemistry at Yale University from 1908 to 1918 and director of the research laboratory of the Haskelite Manufacturing Corporation from 1918 to 1931, died on April 17 at the age of fifty-seven years. Dr. Drushel is best known for his numerous research papers in certain phases of colloid chemistry and related subjects.

PHILIP R. LOWRY, assistant professor of economic entomology and assistant entomologist of the Experiment Station at the University of New Hampshire at Durham, died on April 30 at the age of thirty-five years, while working in the entomological laboratory of the university.

HENRY F. HOLTZ, associate professor of soils at the Agricultural Experiment Station, State College of Washington, died on April 20.

FERDINAND F. CREVECOEUR, an amateur naturalist, who is the source of many plant, bird and insect records from Onaga, Kansas, died on April 7 at the age of sixty-nine years. He published nine articles in the *Transactions* of the Kansas Academy of Science from 1903 to 1922. A biography has been prepared for publication in the *Transactions.*

DR. JAMES LORRAIN SMITH, F.R.S., professor of pathology and for some years dean of the faculty of medicine at the University of Edinburgh, died on April 18.

THE death is announced of Dr. Wilhelm Valentiner, professor of astronomy at the University of Heidelberg.

SCIENTIFIC EVENTS

THE BERMUDA BIOLOGICAL STATION FOR RESEARCH

IN 1903 the Bermuda Biological Station was established under the joint auspices of Harvard University, New York University and the Bermuda Natural History Society, and it has been continued every year since that time under the directorship of Dr. E. L. Mark, of Harvard University. During all these years it has occupied rented property in Bermuda, and in spite of limited facilities about two hundred and eighty investigators have studied at the station and have published more than 160 papers on the work done there.

In 1925–26 the station was reorganized under a corporation consisting at present of 180 scientists and public-spirited citizens of the United States, Bermuda, Canada and Great Britain. A board of trustees, consisting at present of 20 residents of these countries, was elected by the corporation, and articles of incorporation were granted by the State of New York on June 28, 1926.

Committees of the trustees have visited Bermuda several times to select the best available site for the station and to secure the cooperation of the Bermuda Government. After careful investigation of many sites, and after the selection and subsequent abandonment of one of these, a property known as "Shore Hills" in St. George's Parish, near the northeast end of the Bermuda group, was finally chosen. The Bermuda Government contributed £5,500 toward its purchase on condition that the trustees secure £50,000 elsewhere, the Rockefeller Foundation met this condition, and on March 26, the Bermuda Biological Station took possession of "Shore Hills," one of the finest properties in St. George's Island.

The buildings are now being remodelled for laboratory and residential purposes. In the main building, which was formerly a sanitarium-hotel, there will be in the basement a physiological laboratory, with accommodations for five or six workers, an aquarium room, a dark room, a cold room and a chemical store room, as well as kitchen, laundry and other rooms for household purposes. On the first floor will be a large general laboratory 24′ x 40′ with accommodations for eight or more investigators, and eight private laboratories, all of them supplied with aquaria and running salt water, as well as with A.C. current of 110 volts. There are also on the first floor a living room, dining room, serving room and extensive verandas which can be used for laboratory purposes as well as for recreation. On the second floor are rooms for the library, twelve bath rooms and eighteen bedrooms, each with an outdoor sleeping porch; many of these can be converted into private laboratories if the need should arise. On the third floor are seventeen bedrooms, and four baths in addition to store rooms. The grounds of more than fourteen acres contain in addition to the main building five cottages,

an engine house, a bathing pavilion and boathouse, tennis courts and a portion of a golf course. On the whole, no more delightful place for residence and for scientific work can be found in the western Atlantic. The region around Shore Hills is peculiarly favorable for biological and oceanographical work. There is easy access to coral reefs and heads with their wealth of marine life and the deep ocean can be reached in a few minutes in three different directions. The station now possesses a small launch and several rowboats and a larger motor boat will be provided in the future.

It is expected that funds will be available to appoint a scientific director and staff and to keep the station open throughout the entire year, but for the present arrangements are being made for a session of eight weeks beginning on June 15. No formal instruction will be offered, but approved investigators and research students will be welcomed as far as accommodations will permit.

Room and board will be furnished in the main building during regular sessions at actual cost. Microscopes, special apparatus and unusual or costly chemicals that may be required should be brought by investigators; the station will supply the more usual apparatus, including glassware and chemicals, but no sales department will be maintained.

Bermuda is reached by two lines of regular steamers from New York as well as by other lines that are not so regular. Boats of the Furness Bermuda Line sail from Pier 95, North River, at the foot of 55th Street, Manhattan, every Wednesday and Saturday at 11 A. M. New York time. The usual time of trip is 48 hours or less. On reaching Bermuda those who wish to go to the Biological Station by the shortest and least expensive route should leave the steamer by the tender going to St. George and go from there to Shore Hills, one and a half miles distant, by carriage or launch. Workers at the station and their families can secure through the station reduced rates of transportation (first class) from New York to Bermuda and return. From May to December the round-trip ticket costs $40 plus the governments' taxes of $6; from December to May, $60 plus the same taxes.

In the distribution of duties for this season, Dr. Harrison has consented to look after the transportation of investigators from New York to Bermuda and return. Persons desiring to make use of the facilities of the new station should, therefore, apply as soon as possible to Professor Ross G. Harrison, Osborn Zoological Laboratory, Yale University, New Haven, Connecticut, for sailing accommodations, and information regarding equipment, clothing, etc.

THE SIXTH INTERNATIONAL CONGRESS OF GENETICS

THE year of 1930 may be considered as having been one of preliminary organization for the Sixth International Congress of Genetics, which will be held under the presidency of Dr. T. H. Morgan, California Institute of Technology, at Ithaca, New York, from August 24 to 31, 1932. The year of 1931 is being used to collect the basic financial resources on which the congress must depend, to plan the major features of the program and to work out ways and means for bringing invited Europeans to this country and for utilizing their time wisely after they have arrived.

The council of the congress consists of R. C. Cook, American Genetic Association, treasurer; C. B. Davenport, Carnegie Institution of Washington, chairman of the finance committee; L. C. Dunn, Columbia University, chairman of the transportation committee; E. M. East, Harvard University, chairman of the program committee; R. A. Emerson, Cornell University, chairman of the local committee; D. F. Jones, Connecticut Agricultural Experiment Station, chairman of the publications committee; M. Demerec, Carnegie Institution of Washington, chairman of the exhibits committee, and C. C. Little, Roscoe B. Jackson Memorial Laboratory, chairman of the council and secretary general of the congress. Monthly meetings have been held in New York.

A *Quarterly Bulletin* containing the latest reports on progress made is issued from the treasurer's office. Those interested can obtain copies by writing R. C. Cook, American Genetic Association, Washington, D. C.

Because of the time which must elapse before the congress, American memberships are still coming in very slowly. If such membership is taken out in 1931 it is at a $10.00 rate, which includes the printed proceedings, whereas, if it is delayed until 1932 the rate is $15.00. It is hoped that a reduced rate, without the privilege of receiving the published proceedings, will be offered to students who have not obtained their doctor's degree. The expenses incidental to the congress are being kept at an absolute minimum.

The congress will naturally provide much the same opportunity for invaluable international contacts as did the recent Physiological Congress at Boston. It is the plan of the council to have the congress complete and extensive, including a comprehensive series of exhibits from genetics laboratories throughout the country. Because of these facts it will undoubtedly draw all zoologists and botanists interested in any phase of experimental work.

Participation on the program will be by invitation only. Those interested in genetics should not, how-

ever, delay in joining until such an invitation is received. They should become members at once by getting in touch with the treasurer.

European members will be entertained in New York during the few days between the date of landing and the opening of the congress at Ithaca. Columbia University has generously agreed to cooperate in this matter.

For any particulars concerning the congress communications should be addressed to C. C. Little, Jackson Memorial Laboratory, Bar Harbor, Maine.

THE NATIONAL ACADEMY OF SCIENCES

At the annual meeting of the National Academy of Sciences, which met in Washington on April 27, 28 and 29, the following officers were elected:

President—Dr. William Wallace Campbell, director emeritus of Lick Observatory.

Vice-president—Dr. David White, U. S. Geological Survey.

Home Secretary—Dr. Fred E. Wright, Geophysical Laboratory of the Carnegie Institution of Washington.

Members of the Council—Dr. W. B. Cannon, George Higginson professor of physiology, Harvard Medical School, and Dr. Roger Adams, professor and head of the department of organic chemistry, University of Illinois.

Professor P. Debye, director of the Institute of Physics at the University of Leipzig, was elected a foreign associate. New members were elected as follows:

Dr. Henry Bryant Bigelow, associate professor of zoology at Harvard University and curator of oceanography at the Museum of Comparative Zoology, director of the Institute of Oceanography at Woods Hole.

Dr. Edwin Broun Fred, professor of bacteriology, University of Wisconsin.

Dr. Edwin Crawford Kemble, associate professor of physics, Harvard University.

Dr. Adolph Knopf, professor of geology, Yale University.

Dr. Robert Harry Lowie, professor of anthropology, University of California.

Dr. Joseph Haines Moore, astronomer, Lick Observatory, Mount Hamilton, California.

Dr. Robert Lee Moore, professor of mathematics, University of Texas.

Dr. Hermann Joseph Muller, professor of zoology, University of Texas.

Dr. George Linius Streeter, director, Department of Embryology, Carnegie Institution of Washington.

Dr. Margaret Floy Washburn, professor of psychology, Vassar College.

At the annual dinner of the academy, over which Dr. Thomas Hunt Morgan presided, the Daniel Giraud Elliot medal for the most meritorious work in zoology or paleontology published during the year was presented to Professor Henry Fairfield Osborn for his monograph on "Titanotheres of Ancient Wyoming, Dakota and Nebraska," the presentation speech being made by Dr. William B. Scott, of Princeton University. The Mary Clark Thompson medal "for the most important services to geology and paleontology" was presented to Dr. E. O. Ulrich, geologist of the U. S. Geological Survey, the presentation speech being made by Dr. Rudolf Ruedemann, state geologist of New York.

SCIENTIFIC NOTES AND NEWS

Professor Henry Fairfield Osborn, president of the American Museum of Natural History, will retire from his office on January 1, 1933, on the completion of twenty-five years of service as president of the museum.

Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research, has been elected a corresponding member of the French Academy of Sciences in the section of medicine and surgery. He replaces the late Charles Nicolle, director of the Pasteur Institute in Tunisia.

The doctorate of laws was conferred on May 1, by the University of Michigan, on Dr. James Rowland Angell, president of Yale University. The late James Burrill Angell, father of Dr. Angell, was president of the University of Michigan for forty years.

On the occasion of the installation of Dr. David Robertson as president of Goucher College, on April 24, the honorary doctorate of laws was conferred on Mrs. Herbert Hoover, in recognition of her work, in collaboration with the President, in translating from the Latin Agricola's "De Re Metallica." Degrees were also conferred on Dr. Winifred Clara Cullis, Sophia Jex Blake professor of physiology in the University of London, and on Dr. Florence Rena Sabin, member of the Rockefeller Institute for Medical Research. Addresses were made by Dr. Robert A. Millikan and by Dr. Cullis.

Dr. Walter Dill Scott, president of Northwestern University, and Mrs. Scott, also a graduate of Northwestern University, were the guests of honor at a formal banquet at the Blackstone Hotel, Chicago, on May 1. This banquet celebrated President Scott's tenth year as chief executive of the university, and took place on his sixty-second birthday. Dr. Scott

was previously for twenty years professor of psychology at Northwestern University.

DR. SIEGMUND FREUD, professor of neurology at the University of Vienna, celebrated his seventy-fifth birthday on May 6. A dinner was given in his honor on that day at the Hotel Ritz-Carlton in New York City. Dr. Freud, however, was unable to visit the United States.

DR. CHARLES E. PELLEW, adjunct professor of chemistry at Columbia University from 1897 to 1910, has been readmitted to British citizenship and has taken his seat in the House of Lords as Viscount Exmouth.

THE Royal College of Surgeons has awarded the Jacksonian Prize for 1930 to Edgar S. J. King, of the University of Melbourne, for his essay on "The Pathology of Ovarian Cysts and its Bearing on Their Treatment." The John Hunter Medal and Triennial Prize for 1928–30 was awarded to Mr. Layton, of Guy's Hospital, for his contributions to otology and for his valuable services to the museum, particularly in connection with the Onodi Collection. The Walker Prize for work on the pathology and therapeutics of cancer for 1926–30 was awarded to Sir G. Lenthal Cheatle, and the Cartwright Prize for 1926–30 was awarded to F. W. Broderick, of Bournemouth, for his essay on "The Etiology, Pathology and Treatment of Chronic General Periodontitis."

DR. FAY-COOPER COLE, professor of anthropology at the University of Chicago, has been elected president of the Geographical Society of Chicago.

THE thirty-sixth annual meeting of the Michigan Academy of Science, Arts and Letters was held in Ann Arbor on March 19, 20 and 21. The new officers include Dr. W. B. Hinsdale, professor emeritus of medicine and custodian of Michigan archeology in the University of Michigan Museums, *President;* Professor H. T. Darlington, director of the Botanical Garden at Michigan State College, *Vice-president.* Dr. L. J. Young, associate professor of silviculture, and Dr. E. C. Prophet were reelected secretary and treasurer, respectively.

DR. FRANCIS CARTER WOOD, New York, was elected president; Dr. Edward B. Krumbhaar, Philadelphia, vice-president, and Dr. William H. Woglom, New York, was reelected secretary and treasurer, of the American Association for Cancer Research at its recent meeting in Cleveland.

DR. WALTER RICHARD MILES, professor of experimental psychology at Stanford University, has been appointed professor of psychology at Yale University, where he has been research associate during the past year. Dr. Catharine Cox Miles has been appointed clinical professor of psychology.

DR. JOHN ALBERT KEY, at present assistant professor of clinical orthopedic surgery in the Washington University School of Medicine, has been appointed professor of clinical orthopedic surgery to succeed Dr. Leroy C. Abbott as head of the division of orthopedic surgery in the Washington University School of Medicine.

DR. EDGAR ANDERSON, since 1922 geneticist at the Missouri Botanical Garden and assistant professor at Washington University, St. Louis, has been appointed arborist of the Arnold Arboretum of Harvard University.

THE REVEREND JAMES BERNARD HENRY has been appointed director of the observatory of the University of Santa Clara, California, to succeed the late Jerome Ricard.

DR. ALFRED W. FRANCIS has resigned from Arthur D. Little, Incorporated, to join the research staff of the Vacuum Oil Company in Paulsboro, New Jersey.

MR. CYRIL AINSWORTH has been appointed assistant secretary of the American Standards Association. Mr. Ainsworth, who has been in charge of the association's safety code work during the past year, succeeds Mr. F. J. Schlink, who recently resigned to give full time to the technical direction of Consumers' Research, Incorporated.

Industrial and Engineering Chemistry reports that Dr. T. E. W. Schumann, since January 1 professor of mathematical physics at West Virginia University, Morgantown, has been appointed director of the Fuel Research Board of the Union of South Africa, and will take up his work there in June. Dr. Schumann was educated at the University of Stellenbosch in South Africa and at the University of Göttingen, and subsequently studied at Yale and at Columbia.

THE Committee on Scientific Research of the American Medical Association has awarded a grant to Dr. Maurice L. Cohn, who is collaborating with Dr. H. J. Corper, director of the Research Laboratories, National Jewish Hospital at Denver, Colorado, for the purpose of studying methods of cultivating tubercle bacilli.

DR. J. G. HUTTON, associate professor of agronomy at South Dakota State College, has been appointed chairman of the committee on soil conservation of the American Soil Survey Association.

DR. SAMUEL W. STRATTON, of the Massachusetts Institute of Technology, who has been in Europe, arrived in New York on April 29.

DR. CHARLES A. SHULL, professor of plant physiology at the University of Chicago, is spending the spring quarter carrying on research and lecturing at the Oregon State Agricultural College at Corvallis.

LEAVE of absence from Harvard University for the first half of the next academic year has been granted to Dr. Roland B. Dixon, professor of anthropology and curator of ethnology, and for the second half year to Dr. Walter F. Dearborn, professor of education and director of the psycho-educational clinic.

THE Gehrmann Lectures at the University of Illinois will be given on May 12, 13 and 14 by Dr. Alice Hamilton, of Harvard University, on "Recent Advances in Industrial Toxicology." Adolph Gehrmann was professor of bacteriology and hygiene at the University of Illinois from 1894 to 1918 and died in 1920. The lectureship was endowed by his family and the lectures are given each year on some phase of hygiene and public health.

THE sixteenth Mellon Lecture of the Society for Biological Research, of the School of Medicine, University of Pittsburgh, was delivered on April 23 by Dr. Florence R. Sabin, member of the Rockefeller Institute for Medical Research. Her subject was "Status of the Cellular Reactions in Tuberculosis." This lecture is given each year through the generosity of Mr. R. B. Mellon, who has provided an endowment fund, enabling the society to invite some eminent investigator in the medical sciences.

DR. EDWARD STARR JUDD, of the Mayo Foundation, Rochester, Minnesota, president-elect of the American Medical Association, gave the first address of the Mayo lectureship in Surgery of Northwestern University Medical School at the Murphy Memorial on April 22, on "Fundamental Problems Associated with Disease of the Biliary Tract." This lectureship was endowed by Dr. Charles H. Mayo, Rochester, for the advancement of education and learning in surgery. Every fifth year the lecture is to be given by a foreign physician, the intervening four lectures to be given by American surgeons.

PROFESSOR K. FREUDENBERG, of the department of carbohydrate chemistry at the University of Heidelberg, delivered a series of lectures on organic chemistry at Iowa State College on April 24 and 25.

DR. GEORGE K. BURGESS, director of the Bureau of Standards, delivered on April 18 a lecture before the Royal Canadian Institute on "The Bureau of Standards."

DR. R. A. MILLIKAN, of the California Institute of Technology, was the Chapel speaker at Iowa State College on April 19 and lectured the following day on "Cosmic Rays."

THE Edgar F. Smith birthday lecture will be delivered in the Harrison Laboratory of Chemistry of the University of Pennsylvania on May 22, at 4 o'clock. The lecturer will be Professor N. V. Sidgwick, of Oxford University. His subject will be "Atomic Cohesion"—a consideration of the forces by which atoms are attached in molecules, and molecules to one another in crystals, under different conditions.

DR. CHARLES N. FREY, director of the Fleischmann Laboratories, New York City, recently addressed the Purdue chapter of Sigma Xi on "Vitamins, a New Industry."

THE St. Louis University Sigma Xi Club held on April 30 a symposium on "The Structure of Matter" which was taken part in by James I. Shannon, S.J., professor of physics; Leonard F. Yntema, professor of chemistry; Franklin E. Poindexter, instructor in physics; Fred W. Laird, instructor in chemistry, and James A. McWilliams, S.J., professor of cosmology.

THE one hundred and seventy-first regular meeting of the American Physical Society will be held at the California Institute of Technology, Pasadena, from June 15 to 20, in affiliation with Section B of the American Association for the Advancement of Science. The Monday, Tuesday and Thursday sessions are to be devoted to symposiums of invited papers. On Wednesday the American Physical Society is invited to attend a session of invited papers arranged by the Astronomical Society of the Pacific in affiliation with Section D of the American Association. The regular meetings of the Physical Society for the reading of submitted papers will then come on Friday and Saturday.

REPRESENTATIVE workers in mollusks at a meeting of the Academy of Natural Sciences of Philadelphia have organized the American Malacological Union for the purpose of promoting the science and furthering the interests of students and collectors. Dr. Norman W. Lermond, curator of the Maine Academy of Science, was chosen as one of two secretaries and Dr. C. W. Johnson, curator of the Boston Society of Natural History, was elected treasurer. The new organization is planned to take the place of the former American Association of Conchologists, which has been inactive for a number of years.

THE American Dairy Science Association for the first time will hold its annual meeting on the Pacific Coast. It will meet in July, with the division of dairy industry of the University of California as the host. Dr. H. B. Ellenberger, head of the department of dairy industry, University of Vermont, is president of the association, and R. R. Graves, chief of the division of breeding, feeding and management investigations, Bureau of Dairy Industry, U. S. Department of Agriculture, is secretary-treasurer. The program committee consists of Dr. C. L. Roadhouse, head of the division of

dairy industry, University of California; Professor H. P. Davis, chairman of the department of dairy husbandry, University of Nebraska, and Professor M. Mortensen, head of the department of dairy industry, Iowa State College. This year's meeting will consist both of a formal program for the presentation of papers reporting recent progress in the dairy industry, and tours in the states of California, Oregon and Washington. The meeting will open on July 7 with a preconvention tour from Los Angeles. The formal program for the presentation of papers will be at the College of Agriculture, University of California, at Davis, on July 14. From Davis the tour will be continued northward into Oregon and Washington.

THE Eighth International Congress of Photography will be held at Dresden from August 3 to 8, the last day in Berlin. It has been organized by a committee composed of members of the German Committee of the "Commission Permanente des Congrès Internationaux de Photographie," of representatives of the "Deutsche Gesellschaft für Photographische Forschung," and of the "Deutsche Kinotechnische Gesellschaft." Professor Albert Einstein has consented to be honorary chairman and will open the congress with a lecture. During the congress general lectures will be given on the progress made in various departments of photography and cinematography. There will be special papers in four sections. It is proposed that on the last day of the congress the members shall have the opportunity of attending the making of a talking film at the Ufa studios at Neubabelsberg near Potsdam.

WE learn from the *British Medical Journal* that during the International Colonial Exhibition in Paris this coming summer there will be held a Congress of Tropical Medicine and Hygiene from July 22 to 31, under the presidency of Professor Tanon, who occupies the chair of hygiene in the Paris Faculty of Medicine. The subjects to be discussed include infant and child welfare; the anopheles and stegomyia problems; questions of food, drinking water, and intestinal parasitic diseases in tropical countries; emigration and the exclusion of epidemic diseases at ports; leprosy; the campaign against syphilis, and trypanosomiasis. Two days will be devoted to aviation in its public health aspects; Dr. Charles Richet will preside over this section, and there will be a special demonstration of various kinds of equipment. Attention will also be devoted to the French colonial health resorts. There will be a large number of official receptions and excursions to places of interest.

THE Society for the Prevention of Blindness has established a quarterly journal, *The Sight-Saving Review*, which will unite the scientific, educational, industrial and social forces striving to prevent blindness and conserve vision throughout the United States. The editor is Lewis H. Carris, and there is an editorial board consisting of Mary Beard, assistant director, International Health Division, Rockefeller Foundation; E. V. L. Brown, M.D., professor of ophthalmology, Rush Medical College; A. J. Chesley, M.D., Health Commissioner of the State of Minnesota; Charles L. Close, manager, Bureau of Safety, Sanitation and Welfare, the U. S. Steel Corporation; Gladys Dunlop, supervisor of braille and sight-saving classes of Detroit; Mary V. Hun, chairman, New York State Commission for the Blind; Edward Jackson, M.D., emeritus professor of ophthalmology, School of Medicine, University of Colorado; Albert B. Meredith, professor of education, New York University; A. L. Powell, manager, Eastern Office, Nela Park Engineering Department, General Electric Company; C. O. Sappington, M.D., director, Industrial Health Division, National Safety Council; William F. Snow, M.D., general director, American Social Hygiene Association; William H. Wilmer, M.D., director, Wilmer Ophthalmological Institute, Johns Hopkins University; Thomas D. Wood, M.D., professor of health education, Teachers College, Columbia University.

A PORTION of the summit of the Cascade Range and other scenic country has been added to Mount Rainier National Park. In addition to enriching the natural scenic features of the park and greatly increasing its educational features, this boundary change simplifies administration, protection and development of the park. It affords a natural boundary on the east, based on topographic conditions, and includes as the east park gateway Chinook Pass, which affords an unusually spectacular entrance. Through it will run the new road connecting Yakima and Seattle. A factor in the addition to the park was the need for including in it the only feasible location for the new road to be built by the National Park Service to connect up with the new state highway on the east. All other possible locations were found to be excessively expensive. In all, a total of approximately 34,000 acres of land was added on the south and east boundaries.

THE new School of Public Health and Tropical Medicine at the University of Sydney has passed through its first year with considerable success according to a report in the *British Medical Journal*. The activities of the school include not only instruction and research in tropical medicine and public health, but also special education in school and building hygiene. Altogether 158 students attended during the year. Of these, 9 were medical graduates, 39 were medical undergraduates, 11 were students of

social hygiene, 9 were architectural students and 90 were graduate school teachers. Three diplomas in tropical medicine and two in public health were granted. The course in tropical medicine occupies a period of three and a half months, and corresponds closely to those of London and Liverpool. The faculty of medicine in the university has recognized the importance of the school by appointing its director, Dr. Harvey Sutton, professor of preventive medicine. This is the first chair in Australia in this branch of medicine. A hookworm and filariasis survey of Norfolk Island was undertaken during the month of January, 1931, completing the hookworm survey of the Australian Commonwealth, Papua and the Mandated Territory of New Guinea. This work, which was conducted for a period by the Rockefeller Institute in collaboration with the Commonwealth Government, has been carried on by the Commonwealth Health Department.

THE German Hygiene Museum at Dresden, which sponsored the International Hygiene Exhibition last year on the occasion of the opening of its new building, reports, according to *Museum News*, that 7,200,000 people visited the exhibition from May 15 to October 1, 1930. In view of the world-wide interest, the directors have decided to repeat the exhibition during the same period in 1931. Many of the foreign governments are enlarging their exhibits and it is said that the participation of the United States Government seems to be assured. In the museum itself the exhibits dealing with the health of the mother and child have been amplified and the exhibits on biology and comparative anatomy have been completely revised and enlarged. In anticipation of the exhibition, the museum has opened offices in several cities throughout the world. The American office is in charge of Dr. R. Woerner, at 1880 Broadway, New York City.

DISCUSSION

CRYSTALLINE PEPSIN OF NORTHROP

THE comprehensive investigation of Dr. Northrop on the crystalline pepsin prepared by him justifies the conclusion of the protein nature of this enzyme and makes probable the individuality of the crystalline substance. Its low isoelectric point stands out as the most characteristic property of the substance from the physicochemical view-point. It seemed to us of importance to detect some purely chemical characteristics of the crystalline pepsin, and with the consent of Dr. Northrop such an investigation was undertaken in this laboratory.

In course of the study of the products of hydrolysis of the crystalline pepsin which is now in progress, a peculiarity was found in the composition of this protein which differentiates it from any other protein, namely, the extremely small content of the basic components. Thus, the twice crystallized material contained only 4.65 per cent. of its total nitrogen in the form of basic substances. The significant feature, however, is that the material crystallized five times contained only 3.3 per cent. of its total nitrogen in the form of basic nitrogen.

The conclusion to be drawn, then, is that the crystalline pepsin, in the main, is an individual protein but it probably contains a small admixture of an extraneous protein. We are endeavoring to prepare the crystalline material free from the impurity.

P. A. LEVENE
J. H. HELBERGER (Munich)
THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

VITAMIN D IN WHOLE CORN

IN SCIENCE of January 23, 1931, Harris and Bunker[1] reported irregularity in the development of rickets in rats fed on diet No. 2,965 of Steenbock and Black.[2] The authors suggested that this may have been due to the presence of antirachitic factor in the corn contained in the diet.

It is true that of a group of rats fed on the same batch of diet No. 2,965 containing freshly ground whole corn, one or more animals occasionally fail to develop rickets, at least in the usual period of observation. This also holds true for diet No. 3,143 of McCollum,[3] if administered in the form in which it is usually prepared. But most investigators of experimental rickets have attributed this rather unusual occurrence either to a large store of antirachitic factor in such animals or to partial or complete inanition which interferes with the development of the disease. Another possibility that must always be ruled out is the contamination of the cage by a minute amount of very potent antirachitic substance (irradiated ergosterol) that may have been used in a previous experiment. Most investigators of the subject have now had this untoward experience. I am of the opinion that a fourth very likely explanation is the settling out of the calcium carbonate of the diet so that, as consumed by the animal, it does not have the high ratio of Ca to P which is a necessary condition for the production of rickets by this diet. Even if the diet is thoroughly

[1] R. S. Harris and J. W. M. Bunker, SCIENCE, 73: 95, 1931.

[2] H. Steenbock and A. Black, *J. Biol. Chem.*, 64: 263, 1925.

[3] E. V. McCollum, N. Simmonds, P. G. Shipley and E. A. Park, *Am. J. Hyg.* 1: 492, 1921.

mixed before serving, and is served fresh daily, the settling out of the calcium carbonate is still a very likely occurrence.

To avoid the settling out of the $CaCo_3$ and NaCl from diet No. 3,143 I have been in the habit of melting the gelatine it contains, in warm water (60 cc to every 15 grams of gelatine), incorporating the remaining constituents of the diet in this solution and stirring thoroughly until the mixture is a solid jelly. This insures the maintenance of the even distribution of the soluble and insoluble ingredients of the diet and keeps the ratio of Ca: P quite constant. A weighed portion of the jelly is served to the animal, and the residue is weighed after an interval of 24 hours to determine the amount consumed. It is easier to do this when the food is served in this form rather than in the form of a dry granular mixture, because the residue is in the form of one or a few dry masses which do not fall through the wire floor of the cage and can be easily separated from the feces. This form of diet No. 3,143 is eaten greedily by young rats and they develop a remarkably uniform degree of severe rickets in the usual period of four weeks.

Recently Shohl and Brown,[4] working with diet No. 2,965, modified by the addition of calcium or phosphorus compounds, so that the ratio of Ca to P was varied in a number of ways, obtained rather unexpectedly irregular results. Upon the assumption that the cause may have been the inconstancy of the various ratios of Ca: P, they have adopted the above method of maintaining them constant. They have effected this by replacing 6 per cent. of the corn in diet No. 2,965 by gelatine, and by incorporating the other ingredients in the jelly, as outlined above for diet No. 3,143.

It is not claimed that the results of Harris and Bunker[1] are accounted for by any of the explanations given above, but it seems timely to draw attention to some of the other possible explanations of the occasional irregular results obtained with rickets-producing diets served in the usual form of dry, granular mixtures, and to indicate a way of avoiding one of the causes.

HARRY GOLDBLATT
INSTITUTE OF PATHOLOGY,
WESTERN RESERVE UNIVERSITY

[4] A. T. Shohl and H. B. Brown (unpublished).

VIABILITY AND RETENTION OF VIRULENCE OF A CULTURE OF CORYNEBACTERIUM DIPHTHERIAE

IN December, 1928, a pure culture of *C. diphtheriae* was isolated from the throat of a patient. It fermented glucose and gave a typical virulence test in guinea pigs. The culture was grown on chocolate agar, placed in the refrigerator at the time of maximum growth, and transplanted every two weeks until June, 1929. At that time generous loopfuls of culture, each mixed with a drop of sterile rabbit's blood, were placed on each of a number of small bits of sterile filter paper, transferred to sterile Wassermann tubes, and kept *in vacuo* in anaerobic jars (Smillie) for a period of three months. The anaerobic jars were kept in an electric refrigerator.

In October, 1929, the culture was removed from the anaerobic jar, grown in meat infusion broth for twenty-four hours, and then planted on chocolate agar. It grew well, fermented glucose, and again gave a positive virulence test in guinea pigs. The culture was kept *in vacuo* for a second period of three months in the summer of 1930 and, when used for class work in December last, appeared to have undergone no loss of virulence.

It is known that *C. diphtheriae* survives preservation *in vacuo* after the method of Brown,[1,2] but it may be of interest to teachers to know that the culture will remain virulent under such simple conditions as those described.

LAURA FLORENCE
DEPARTMENT OF BACTERIOLOGY, PUBLIC HEALTH, AND CLINICAL PATHOLOGY, NEW YORK HOMEOPATHIC MEDICAL COLLEGE

[1] J. H. Brown, *Abs. Bact.*, 9, No. 1, 1925.
[2] *Ibid.*, SCIENCE, 64: 429, 1926.

FORMALIN POISONING

FEW laboratory workers in the biological sciences have escaped some disagreeable experience with formalin. I know one pathologist who always wears gloves to hide the condition of his skin and another who should if he valued appearances. His hands are swollen, discolored and cracked. (Since I first wrote this he has gone into the hospital with a severe infection that started in these sores.) When I last saw my former anatomy professor he had both hands bandaged for formalin sores. I never heard that sinus or lung trouble had been traced directly to inhaling the fumes, but in some cases they are very irritating to the mucous membrane.

One of the worst features of formalin is the insidious and cumulative nature of the trouble it causes. A person may use it for a year or more before any symptoms appear; then the skin of the hands begins to dry, harden and form painful cracks that heal very slowly. Sometimes suppuration starts under the nails. After the victim has once become susceptible he generally has the trouble with him as long as he has anything to do with formalin. Rubber gloves give only partial protection, for a very slight exposure is enough to start trouble.

Formalin is such a useful laboratory reagent that it is almost impossible to avoid some contact with it. Aside from alcohol and water it probably has more uses than any other fluid.

When I asked a dermatologist if he knew any antidote or remedy he replied: "No, it is a good deal like a hot stove; you must keep your fingers off if you don't want them burned." I have tried ammonia, glycerine and various oils and lotions on my hands with only slight relief.

The purpose of this article is to appeal to the pharmacologists for a remedy; or still better to the organic chemists for some substitute, with which at a reasonable cost we may preserve our dogfish, kill and fix tissues, fumigate sick rooms, disinfect seed grain, poison the flies, etc., etc., while avoiding the irritating properties of formalin.

PHILIP H. POPE

WHITMAN COLLEGE

BASKING SHARKS ON THE PACIFIC COAST

THE staff of this station were interested in Mr. Gudger's account of the capture of a basking shark, *Cetorhinus maximus,* taken on the New Jersey coast near Long Branch, an account of which appeared in SCIENCE of October 3, 1930. We were interested not because of the strangeness of such a catch, but because so much space was given to an animal which is so common with us that we may see one almost any day during December and January.

Twenty-one of these sharks were sold to the Monterey Fish By-Products Plant, of Seaside, Monterey County, California, between the dates of November 22, 1930, and February 13, 1931, the average weight being 2,523 pounds. The largest was 6,580 pounds and 28 feet long, the smallest 900 pounds and 15 feet long. The largest shark sold to the above firm at any time was a few inches under thirty feet and weighed 8,600 pounds. The liver of this shark weighed 1,800 pounds, 60 per cent. of which was oil.

Because this fish feeds directly upon plankton, the oil is clear, odorless and tasteless when carefully prepared; and, in the writer's home, has been substituted for commercial cod-liver oil purchased at drug stores.

Little is known regarding the migrations of this shark on the Pacific Coast; in fact, little is known about it at all. It is a cold water form (which would be obvious because of its use of plankton for food), but it has been seen in numbers at different times of the year as far south as San Simeon Bay, California, and there are records of its having been taken at both San Pedro and San Diego. A 2,000 pound specimen was taken here at Monterey Bay, May 19, last year; and another, 26 feet long, 6,200 pounds, September, 1928; so apparently they occur all the year, but are most plentiful during December and January.

The reasons more of these sharks are not taken are that the price paid fishermen is only $2.50 per ton, and the animals are so difficult to handle that fishing crews do not feel justified in equipping their boats for taking them.

They are now used entirely for fertilizer or chicken feed, the liver oil being used in the preparation of the latter. No doubt *Cetorhinus* will be taken in increasing numbers when the real value of the oil is appreciated as a substitute for cod-liver oil.

Two parasite copepods, *Anthosoma crassum* and *Denemature producta,* were taken from the 6,200 pound specimen.

G. E. MACGINITIE

HOPKINS MARINE STATION

COLOR

SOME philosophers have discussed the question whether color is exclusively a mental phenomenon or whether it resides in a colored object. In the temporary exhibit of color organized by Dr. I. H. Godlove at the Museum of Science and Industry, New York City, there was exhibited a diagram which should help us to a better understanding of this problem.

The diagram has a red block in the center, a source of light on one side and the eye of an observer on the other. This shows that color, as connected with some definite object, is a complex phenomenon consisting of three elements. If any one of the three is missing there is no color. We have no right to say that the color resides exclusively in the mind, the object or the source of light.

We may well carry the analysis much further and distinguish the following items:

(1) A periodicity in the motion of electrons, atoms and molecules in the source of light. That we may have a red color this periodicity must vary within narrow limits on both sides of 500 000 000 000 000 periods a second.

(2) The passage of this periodicity from the source of light to the object in such a manner that the number of periods a second is accurately conserved, but with wave lengths and velocity dependent on whether it passes through a vacuum, air, water or some other transparent medium.

(3) If the source of light produces other colors than red, the object must absorb these and contain molecules which will respond to the periods of red light and send out in all directions light having only that periodicity.

(4) The passage of this selected periodicity to the eye.

(5) A change in the velocity of light as it passes into the eye of such a character that the light is brought to a focus on the retina.

W. A. NOYES

THE ORIGIN OF COSMIC RAYS

A PAPER which I presented at the Indianapolis meeting of the American Chemical Society has been erroneously reported in the Science News Supplement of SCIENCE; I do not wish to publish at the present time the details of this work, but I feel that there should be in the literature some compensating statement of my real views.

The paper under discussion dealt with the Millikan-Cameron theory of the origin of cosmic rays. According to this theory a cluster of electrons and protons is gradually built up and spontaneously collapses to form an atomic nucleus, emitting a cosmic ray. I pointed out that on the basis of our present knowledge this clustering process must be supposed to involve triple collisions, and that the rate of these collisions was insufficient by a factor of at least 10^{10} to give the observed cosmic ray intensities. The report to which I object omitted all reference to clustering and to triple collisions, and had me calculating the rate of simultaneous collision of 84 particles, retaining however the relatively small factor of discrepancy, 10^{10}, expressed more quaintly as ten million billion; it is certainly unfortunate that the writer of this account did not know that if I had ade the calculation to which he referred (as I have now done) I should have found a discrepancy not of merely 10^{10}, but of 10^{1700}, which could no doubt be expressed in some picturesque popular way by one sufficiently imaginative.

The account concludes with the statement that my calculations are based solely on the formation of iron atoms; this is not so.

LOUIS S. KASSEL
4800 FORBES STREET,
PITTSBURGH, PENNSYLVANIA

QUOTATIONS

THE CHEMICAL EXPOSITION

THE week of May 4 will find the Thirteenth National Exposition of Chemical Industries established in the Grand Central Palace in New York with as much space occupied as on former occasions and with a number of new exhibits. The exposition is more than an assembly of new and improved equipment, chemical products, raw materials of the chemical industry, and related items. Admittedly conducted as a commercial enterprise, the exposition nevertheless has become established as an important factor in the chemical life of America. Those familiar with the history of the exposition and the concurrent development of American chemical industry agree that the former has had a great influence upon the latter. It is well to recall that in those early days it was the exposition that served to emphasize the ability of our equipment manufacturers to provide the necessary devices with which to undertake seriously large-scale production of needed chemicals. It was to the earlier expositions also that manufacturers brought the first fruits of their efforts to show how successful they had been in a comparatively new and untried field. Those responsible for the advance of our chemical industry also came in numbers and found the opportunity to decide major questions after conversation with their colleagues.

The exposition is not without an enviable record of services rendered to the exhibitors. Orders approaching a quarter of a million dollars have been known to be placed with exhibitors during the exposition week, and some of the largest purchasers came from foreign lands to see and to buy. The publicity incident to the exposition's activities has been dignified and constructive, thereby adding its bit to our success in winning the sympathy of the general public.

There has been the educational side. Students, accompanied by instructors, have attended, but far more should make the most of the opportunity. However, those who have come—and the number has increased as we have gone along—have been able to see in the compass of a week more pertaining to their work than would be possible in weeks of travel to the various plants and warehouses. The students' courses have called for the cooperation of well-trained specialists, who have been glad to present discussions on topics chosen by the director of the students' courses to produce a well-rounded program and leave the lasting impression which comes from the receipt of valuable information.

The event is important from many points of view. That section of the public which comes in the evening can not fail to go away impressed with the fact that this industry, so little known prior to 1914, is now fundamental to public well-being and is conducted on a scale comparable with other commercial enterprises. There will be stockholders interested in more intimate details of the products of various concerns. There are sure to be bankers and financiers, executives and economists, journalists and teachers, among the crowds of plant operatives, technical men, and students. All are a part of the great army of ultimate consumers whom we seek to serve.

The exposition is an occasion of moment. It is a biennial opportunity to get abreast of new developments. It is one of the yardsticks by which we can measure our progress.—*Industrial and Engineering Chemistry.*

SCIENTIFIC BOOKS

Numerical Mathematical Analysis. By JAMES B. SCARBOROUGH, Ph.D. xiv + 416 pp. Johns Hopkins Press, Oxford University Press, 1930.

THE following statement in the preface characterizes the treatment of the subject almost perfectly: "The treatment of all topics has been made as elementary as was consistent with soundness, and in some instances the explanations may seem unnecessarily detailed. For such detailed explanations no apology is offered, as the book is meant to be understood with a minimum of effort on the part of the reader." Owing to this character the book will have friends who love it for its simplicity and lack of obscurities, and will hardly be useful to those who prefer to do some independent mathematical exploring.

The arrangement of the material is that of a textbook, with numerous completely treated examples in the text and problems for exercise at the end of each chapter. These examples and problems show a remarkable and pleasant versatility.

The subject of interpolation, numerical differentiation and solution of differential equations occupies over one half of the book. The formulas are all derived with elementary algebraical processes without any use of symbolic operators. It is especially in this part of the book that a somewhat higher mathematical standpoint would have saved pages of tedious elimination and would have brought out the mathematical beauty of the subject. Very illuminating are the discussions and examples pointing out the limitations of the formulas and processes. This part of the treatment probably surpasses that in any other existing treatise.

The other chapters deal with numerical methods of solving algebraical and transcendental equations, the theory of errors, empirical formulas and harmonic analysis.

In Article 106 the author objects to the frequently used method for computing the probable error of the result of the combination of different sets of measurements of the same quantity of which the probable errors are given. In the discussion he does not mention the circumstance that usually each set is affected by systematic errors of some kind which were not eliminated, so that the internal probable errors of each set are not a satisfactory indication of the accuracy of the result. This fact justifies and almost necessitates the usual practice of using the deviations of each set from the final result for the determination of the probable error.

The chapter on harmonic analysis deals exclusively with the cases of 12 and 24 ordinates. The efficiency of complete computation schemes which reduce the analysis to mechanical application of simple operations is not too strongly emphasized. In common with other presentations of this subject this chapter has the defect of not mentioning the use of a scheme for synthesis, and of not dealing with the case that arises most frequently; namely, the one in which only two or at most three harmonics are of interest, even though the number of data is much greater than twice the number of harmonics.

The book is beautifully printed; very few typographical errors were noticed.

DIRK BROUWER

YALE UNIVERSITY OBSERVATORY

The Organization of Knowledge and the System of the Sciences. By HENRY EVELYN BLISS, with an introduction by John Dewey. Henry Holt & Co., New York, 1929. $5.00.

THE reviewer was taught in his youth that science was organized knowledge of whatever kind. According to this definition, the book under review is thoroughly scientific. It is an instance of what can be done in the way of converting into a useful volume of reference what otherwise might have been an unreadable wilderness. The reviewer has attempted to read more than one treatise which might have profited by this good example.

The author, as a librarian, has had to do with the organization of knowledge of many kinds, as contained in books and deposited in libraries. In order to make this deposit available without undue loss of time, classification is necessary. It appears that in attempting to extend and improve this classification the author reached a limit set by the lack of a scientific classification in the various branches of knowledge themselves. The librarian is thus led to magnify his office and, like Lord Bacon, to take all learning for his province.

As instances of the breadth of the field into which the author's quest has led him, we may mention his discussion of the national and international organization of scientific men, of social, political and economic organizations, and their intellectual cooperation.

Not the least interesting feature of the book is the author's review of attempts to classify and systematize knowledge from Plato and Aristotle to Comte, Spencer and Wundt. An excellent bibliography with comments and summaries is given.

The work as a whole may be heartily recommended to those who are (or should be) interested in the relations of their own field of knowledge to the fields of others.

PAUL R. HEYL

BUREAU OF STANDARDS,
WASHINGTON, D. C.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A HIGH TEMPERATURE ELECTRIC FURNACE AND A MICRO-ADAPTATION

HOME-MADE electric furnaces are so much in vogue in American university research laboratories that a style of high temperature electric furnace which we have used with considerable satisfaction may be of interest to others.

For temperatures up to 900° or 1,000° C. a very inexpensive and practical electric furnace can be made by winding nichrome wire upon a grooved alundum core and suitably insulating it with two or three inches of magnesia or asbestos. For control a Thordarson A.C. regulator in series with the furnace has been found very satisfactory. It is desirable to have an ammeter also in the hook-up in series. Using number 17 (B&S gauge) nichrome wire a furnace core three inches in diameter can be held at 900° C. on about 10 or 12 amperes with three inches of asbestos packing. Or if wound in parallel with two strands of number 17 (B&S gauge) nichrome wire about 16 or 17 amperes will give the same temperature more rapidly. An ammeter, the scale of which reads to 10 amperes, is quite adequate for this type of work, making possible a highly satisfactory control for the lower temperatures. Such a meter may be shunted to read higher amperages.

For temperatures above 950° C. another heating element should be used. Platinum or one of the platinum metals is popularly selected. Since platinum has been shown to lose weight at the higher temperatures, around 1,500° C., we have resorted to the following expedient to cut down overload on the platinum heating element. An alundum crucible is wound with platinum wire and the whole is imbedded in a block of alundum cement. This is then introduced into the nichrome wound furnace. The mix is placed in a platinum crucible, which in turn is placed in the alundum crucible and covered with an alundum disc. But even with these precautions, it is necessary to proceed carefully to avoid the risk of burning out the platinum element at the higher temperatures.

Unless a rather large melt is wanted, a simple carbon resistance furnace is much preferable, as it is faster and requires less careful operation. Its main limitation is that only a small melt can be made, unless a very high amperage line and control unit are at hand. The furnace described below uses a crucible the size of one's little finger and of any convenient length, made out of an ordinary arc lamp carbon. It has been used on a maximum of 60 amperes A.C. 110 V. and is controlled by two 3 K.V.A., A.C. regulators. For this amperage the temperatures which we have been able to reach have been limited to 2,300° C. measured with a Leeds and Northrup optical pyrometer calibrated by the Bureau of Standards. Theoretically with higher amperage much higher temperatures should be possible, and with higher amperage larger crucibles could be used.

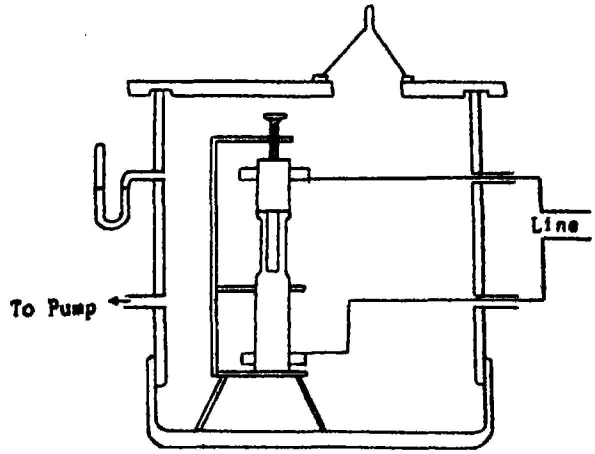


FIG. 1

The furnace itself (Fig. 1) operates under vacuum. It consists of a metal jacket cut from a piece of 8-inch steam pipe, threaded at one end, on which a cap has been tightly fitted. The other end was turned in a lathe to make it true, and on a metal plate a groove was turned to fit the open end of the pipe. Into this groove is fitted a rubber gasket, smeared on both sides with stopcock grease. In the top of the plate a two-inch hole gives a view of the interior. Over this hole is fitted a glass funnel with a similar gasket contact. Into the sides of the pipe have been fitted several ⅜-inch pipes, two of which serve to introduce the lead wires, one for the off take to a Cenco Hyvac pump, and one for a monometer gauge. Others are for special purposes. All seals are made with De Khotinsky cement. The crucible support within the furnace is made of "transite" board; the crucible—an arc lamp carbon drilled out at one end for the desired depth—is fastened into a collar by means of a set screw. The collar in turn is fastened to one of the leads. Another carbon, solid, similarly fastened into a collar and connected to the other lead, is placed on top of the loaded crucible carbon and is pressed into place by an adjustable spring. The crucible itself then offers the greatest resistance in the circuit, since its cross-section shows the smallest amount of conductor. It is therefore its own heating element.

The operation is as follows: After loading the crucible make sure that the upper carbon is in good contact with the top of the crucible to avoid arcing. Adjust the metal plate and gasket in proper position on top of the furnace, and suitably cover the window

opening. Start the vacuum pump and bear down upon the furnace top for a short time until it takes hold. Allow about fifteen minutes for pumping before turning the current on the crucible. The temperature of the crucible rises very fast following the ammeter quite closely. In fact, for careful melts we have found it desirable for one man to follow the crucible temperature with an optical pyrometer while another reads the milliammeter and adjusts the controls accordingly.

Crucibles so made are inexpensive and need not be used more than once. Such a furnace will not function if there are leaks in the system, as the crucible burns readily under such conditions. Some burning is unavoidable, owing to the release of absorbed air on heating. Due to this burning we have not been able to hold a melt at a high temperature for a prolonged period of time. In the selection of carbons to be used for crucibles, soft carbons are preferable to hard carbons.

A modification of this type of furnace has been used to determine *melting points* with moderate accuracy. Drill a hole in the side of an arc lamp carbon and place the material to be melted in the hole. Attach the lead wires to the ends of the carbon and support it on something such as transite board. The whole may then be mounted on a microscope stage and the melting observed while another observer reads the temperature with an optical pyrometer. Since this is not done in a vacuum the carbon burns rather rapidly but there is ample time for careful and deliberate measurements.

Others may have used furnaces similar to those described here. This description is offered at the suggestion of a visitor who expressed surprise that the higher temperatures could be reached so easily, and who believed that there were others who would be interested in these methods.

R. C. EMMONS

UNIVERSITY OF WISCONSIN

SPECIAL ARTICLES

THE STRUCTURE OF GLUCOSE

THE remarkable difference in stability and properties of the pyranose and furanose ring forms, respectively, of carbohydrates and polysaccharides points to some marked fundamental difference in their structure. This point of view receives added emphasis from the lack of a similar striking difference in properties between the five- and six-membered carbon rings.

The old von Baeyer strained ring hypothesis is no longer acceptable in the light of Ruzicka's synthesis of higher-membered lactone and ketone rings. There now appears to be definite evidence for the belief that while in the case of a pentamethylene strainless ring all the carbon atoms lie in one plane, in the case of hexamethylene, as first pointed out by Sachse and Mohr, a strainless ring is only possible if all the atoms are *not* assumed to lie in one plane; in other words, are united as a "puckered" strainless ring (A) or (A′).

It has been tacitly assumed, without any proof, however, that replacement of a carbon atom by oxygen does not influence the valence direction of the carbon atoms, and that the oxygen functions in this respect similar to carbon, namely, with an assumed normal valence angle of 109° 28′.

While it is true that certain X-ray data point to the tetrahedral character of the oxygen atom, the more recent work of Debye, of Sänger and of Williams serves to show that the valence angle of an oxygen atom attached to two carbon atoms, as in ethyl ether, is 32°, in other words, corresponds to that of the oxygen atom when linked with two atoms of hydrogen.

If now this latter value of 32° be taken as the *normal* carbon-oxygen-carbon valency angle, certain very interesting results follow.

For example, it is found that a ring system consisting of five carbon atoms and one oxygen forms a "puckered," strainless, pyranose ring (B). In this the carbon atoms are joined to one another at a (theoretical) valence angle of 109° 28′ and lie in one plane. The –C–O–C linkages with an oxygen valence angle of 32° subtend an angle of 109° 28′ with the plane of the carbon atoms.

On the assumption that in the furanose form (C) all the atoms lie in one plane, and that the *normal* –C–O–C– valence units form a much smaller oxygen valence angle than the system –C–C–C– (32° as compared with 109° 28′) such a ring must represent a strained system and one which should show a marked tendency to undergo ring scission, and ready conversion, under the influence of mild physical and chemical agents into the "puckered," strainless, pyranose ring type. That this must be the case is evident from the simple calculation, $360° - 3(109°\ 28') = 31°\ 36'$, or the approximate angle suggested above for –C–O–C– linkage. It is not necessary to assume that the structure is that of a regular pentagon, inasmuch as the –C–O–C– linkage may represent some value smaller than that assumed in the regular figure.

The theory appears to offer an explanation of many abnormalities occurring between the various isomeric ring structures of carbohydrates and polysaccharides.

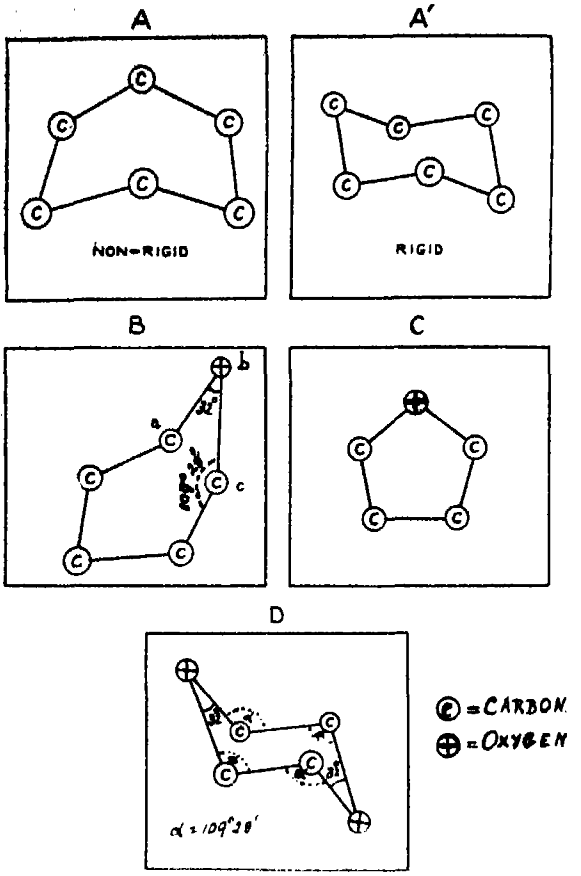


FIG. 1

The above ring forms may be readily demonstrated by use of the Goth carbon models. To represent an oxygen atom, two of the carbon valence bonds are removed from a carbon atom model and the two remaining valence units then bent over so as to subtend an angle of 32°.

It will be seen that in such a model (B) the passage from the "puckered," pyranose ring form into that of the Sachse-Mohr hexamethylene ring type is merely that of a transition of the valence direction of the oxygen atom from 32° to 109° 28′, this being shown on the model in very simple manner by the rotation of the oxygen-valence units *ab* and *bc* into the 109° 28′ position. In the case of the dioxane ring, containing two oxygen atoms, the new theory indicates a strainless ring structure for the compound, as represented by (D). It is seen that a perfectly symmetrical ring is obtained and one therefore having no dipolar moment.

The theory also offers an explanation of the well-known difference in properties found between ethylene oxide derivatives of carbohydrates and polysaccharides, and those of the trimethylene type.

The structures suggested above would seem to apply with equal force to other aldoses, to ketoses, polysaccharides, etc.

It is possible that the remarkable changes occurring in the character of the carbohydrate constituents during plant and animal cell metabolism are to be associated with the marked tendency of the furanose (gamma, active) strained ring type to pass over into the strainless, pyranose, "puckered" ring form as indicated above.

A more complete discussion of the theory is to be given in a forthcoming communication to the *Canadian Journal of Research*.

HAROLD HIBBERT
PULP AND PAPER RESEARCH INSTITUTE,
McGILL UNIVERSITY
(March 25, 1931).

NORTH AMERICAN FRESH-WATER SPONGES

IN order that the records of occurrence of fresh-water sponges in North America may be kept as nearly as possible up to date, I wish to make available the following notes upon the materials with which I have recently worked.

Some years ago while on furlough in South Carolina the writer collected several small bits of fresh-water sponges from a floating log in a fish pond near Summerton, South Carolina, and sent these on to the U. S. National Museum. They were, in the course of time, forwarded to Dr. Frank Smith, who identified them as *Trochospongilla horrida*. This find was of peculiar interest, both because it was, so far as I know, the first fresh-water sponge to be found in South Carolina and also because it was the second time this species, which is a comparatively common one in Europe, had been found in the United States. Dr. Smith had reported it from Illinois in 1921.

Dr. C. McLean Fraser, of the University of British Columbia, gave me a small bit of sponge which had been collected in October, 1925, in Beaver Lake, Stanley Park, Vancouver, British Columbia. This specimen is a typical form of *Spongilla lacustris*.

Professor Y. T. Chu, of St. John's University, Shanghai, China, while studying at Cornell University, Ithaca, New York, in 1925, sent me in September and October of that year two small specimens of fresh-water sponges, one taken from the fish hatchery at the university. This proved to be *Carterius tubisperma;* another from Beebe Lake at Ithaca has proved to be *Ephydatia mülleri* with heavy, smooth skeleton spicules. The opinion which places *Ephydatia japonica* as a synonym of *E. mülleri* is now generally, we believe, accepted. This sponge is very variable and *E. japonica* was separated from *E. mülleri* because it had smooth skeleton spicules: we now know that many specimens of this sponge contain

both the spined and the smooth skeleton spicules, thus providing connecting links between the two formerly supposed distinct species.

In March, 1927, Dr. V. M. Tanner sent me some small specimens of *Spongilla fragilis* collected in the Wasatch Mountains in Utah in a small fresh-water pond at an elevation of 7,800 feet. The gemmules of this sponge are found in two very distinct arrangements in different parts of the sponge: in one case, they are scattered through the sponge structure, being grouped together in the typical *S. fragilis* groups of from three to several gemmules with their pore tubes projecting through the covering layer of materials; in the other case, the gemmules form a continuous layer one gemmule thick, closely bound together by a layer of spongin through which the long pore tubes with their curved ends project.

Dr. Jacques Rousseau, of Quebec, kindly sent me several specimens of a deep green sponge forming short cylindrical growths independently and also around the stems of a water weed. This was collected August 8, 1926, and contained no gemmules, but is readily distinguishable by its form and its flesh spicules as *Spongilla lacustris*. This material was collected from Lake Montauban in Quebec Province. Later on, August 17, 1928, Dr. Rousseau also collected this same species at an elevation of 3,650 feet from Lake Cote, Shikshok Mountains in the Province of Quebec, Canada.

Dr. Charles P. Sigerfoos, of the University of Minnesota, has given me a specimen of sponge collected near Minneapolis, Minnesota. This was very full of gemmules and proved to be an *Ephydatia mülleri* with thin smooth skeleton spicules.

Professor W. H. Cole, of Clark University, Worcester, Massachusetts, has kindly sent me recently a collection of sponges which he made from Sudbury River, Concord, Massachusetts, in September, 1924. This sponge he had already correctly identified and reported as *Spongilla lacustris*.

Dr. S. F. Light, of the University of California, has kindly sent me on separate occasions two small specimens of fresh-water sponges from California. The first one is an interesting form of *Ephydatia fluviatilis* with skeleton spicules varying from smooth to finely spined ones. No special location nor date is recorded on this specimen. The second specimen is from Noyo River, Central Mendocino County, and was a "vivid green in life." This sponge was collected in August, 1929, and has no gemmules in it. While there is some doubt as to its determination on account of the absence of gemmules, it is doubtless a species of *Carterius* and I am inclined to believe that it is *C. tubisperma*. Later collections bearing gemmules will be necessary before a final determination can be reached.

Dr. J. G. Needham, of Cornell University, has recently sent me a small collection of sponges made during the month of July, 1930, in the state of West Virginia. Fortunately most of these specimens can be satisfactorily identified, for they bear gemmules. One of these specimens is a very beautiful lichen or liverwort-like growth closely attached to the surface of a stone as a thin, branching form. This is *Trochospongilla leidyi* and it was collected from a stream near Justice, West Virginia. Another small specimen of the same species forming a thin crust on its support was taken at Guyandotte River, also near Justice.

A specimen of the typical form of *Trochospongilla* (*Tubella*) *pennsylvanica* was found in Elk Garden, Mineral County, West Virginia. A good collection of green *Spongilla lacustris* growing in masses rather than in cylindrical projections was taken from Greenbrier River, Marlington, West Virginia. Another specimen of sponge was collected from the Cacapan River near Wardensville, West Virginia, but since this bears no gemmules and presents no distinctive characteristics to enable one to identify it, I shall not hazard a guess even as to its genus. The skeleton spicules are smooth, of medium size and bear sharp points at their ends.

N. Gist Gee

Rockefeller Foundation,
Peking, China

THE NATIONAL ACADEMY OF SCIENCES

At the annual meeting of the National Academy of Sciences, held in Washington on April 27, 28 and 29, the following papers were presented:

Molecules in the sun's atmosphere: Henry Norris Russell. It was once supposed that the sun's atmosphere was too hot to permit the formation of chemical compounds, but six have now been detected over the photosphere and eight more above the spots. The heat of formation of a number of these compounds is known (from their band spectra) and their dissociation in the sun and stars can be discussed in the same manner as the ionization of atoms. The results are in good agreement with observation. In general, the compounds increase in number and amount at low temperatures. Most of the known compounds contain hydrogen—the most abundant constituent of stellar atmospheres. Oxygen—also very abundant—comes next on the list. The carbon compounds CN and CH show a maximum at temperature a little lower than the sun's. This may be explained if oxygen is in excess, for CO is more firmly bound than the other compounds, and at low temperatures most of

the carbon would go into it. In the cool stars of classes R and N the carbon bands are very strong, as they should be if there is more carbon present than oxygen (confirming a conclusion of the late Professor R. H. Curtiss).

Discovery of three thousand southern double stars at the Lamont-Hussey Observatory of the University of Michigan, at Bloemfontein, South Africa: MORRIS K. JESSUP (introduced by Heber D. Curtis). This observatory, initiated by Dr. W. J. Hussey and established in South Africa through the generosity of Mr. Robert P. Lamont, started a double star discovery program on May 8, 1928. Work at this and other observatories of American origin has been greatly furthered by the friendly generosity of the South African people. The program of observing has been largely concentrated on the discovery of new double stars, systematic searching being carried on to a limiting magnitude of 9.5 in the Cape Photographic Durchmusterung. Good pairs fainter than this limit were not rejected, however. The limits of separation are determined by the formula $\log p'' = A - Bm$, where $A = 2.8$, $B = 0.2$, and m is the visual magnitude of the primary. The observing has been done by three astronomers for the University of Michigan: Dr. R. A. Rossiter, chief observer, and Messrs. Morris K. Jessup and Henry F. Donner. The total production, soon to be published as a volume at Ann Arbor, is made up as follows:

Observer	Total discoveries	Known pairs remeasured	Total measures	Stars observed	Measures per star
Rossiter	1290	165	3336	1455	2.29
Jessup	988	436	3715	1424	2.61
Donner	738	265	2650	1003	2.64
L–H O	3016	886	9701	3882	2.50

Nights wholly or in part suitable for observing at Bloemfontein average about 250 per year.

The determination of the ozone in the upper atmosphere by bolometric measurements: OLIVER R. WULF (introduced by C. G. Abbot). Measurements of the transmission of visible light by ozone have been made on the solar spectrobolometer of the Smithsonian Institution at Table Mountain, California. A large glass cell, placed in the path of the sun's beam before the first slit of the instrument, was filled with controlled amounts of ozone and the weakening of the spectral intensity observed. Some forty satisfactory points for measurement have been chosen, scattered over the visible portion of the solar spectrobologram. These include points on both sides of the region of ozone absorption as well as within it. Using these, it has been possible to define a useful area which is proportional to the amount of ozone in the path, and which is determinable from transmission coefficients. This affords a basis for the determination of the amount of ozone in the upper atmosphere from direct bolometric intensity measurements.

Contact invariants: EDWARD KASNER. The author studies invariant properties of families of curves, or differential equations, under the total group of contact transformations. This includes the group of point transformations as sub-group (topological differential invariants as developed by Blaschke). Among families of ∞^3 curves, the *cubic type* is the simplest, including an interesting *anharmonic type* which is here introduced. Two families of ∞^1 curves (this configuration is termed a *wex*) have invariants. The simplest type of *wex* is defined by a generalization of the Desargues property. An absolute invariant of five differential elements of third order is found. Families of $\infty^1 + 3\,\infty^1$ curves are also introduced with a generalized hexagonal closure property. In conclusion, the author's theory of conformal invariants of horn angles is extended to both the topological and contact groups.

The present status of the telephone art in the United States, and some suggestions for future developments: GEORGE O. SQUIER. When Stephen Gray, an English scientist who died in 1736, discovered the copper wire to guide electricity he made one of the greatest inventions of all history. The telephone system in the United States now controls enough of this wire to reach half way from the earth to the sun. Under present management this vast wire pattern remains dumb and silent except for a few minutes each day. The present radio congestion in our planetary ether demands that Gray's invention be applied in furnishing educational programs free of advertising into the homes of the American people.

The effect of pressure on the quantum anomalies of ammonium chloride and bromide: P. W. BRIDGMAN. Simon has found anomalies in the specific heat of NH_4Cl and NH_4Br at atmospheric pressure at about $-30°$ Centigrade which are not allotropic transitions in the ordinary sense, since there is no change of crystal lattice, but which have been thought to be due to some quantum change, perhaps the acquiring of rotational energy by the molecule. Accompanying the anomaly of specific heat, there is also a volume anomaly of different signs in the two cases, the volume of NH_4Cl increasing anomalously as temperature is raised, while that of NH_4Br decreases. This leads to the expectation of a pressure effect, and this has, in fact, been found. At 0° Centigrade the anomaly in NH_4Cl begins at a pressure of 3,370 kilograms per square centimeter, and at 30° Centigrade at 9,390 kilograms per square centimeter. The transition is completed in a pressure range of about 1,800 kilograms at 0°, and about half this at 30°. A simple analogue of Clapeyron's equation governs the displacement of the transition. In NH_4Br the transition is displaced toward lower temperature by pressure, as would be expected from the opposite sign of the volume anomaly. At $-70°$ Centigrade the major part of the transition occurs at about 1,600 kilograms per square centimeter, and is very much more abrupt than

in the case of NH_4Cl. It will obviously require some modification in the simple picture of the mechanism hitherto described to account for the various differences in the behavior of NH_4Cl and NH_4Br.

Studies on electrokinetic potentials. IX. The electrical field of force at liquid-liquid interfaces: HENRY B BULL and ROSS AIKEN GORTNER (introduced by S. C. Lind). Apparatus was devised whereby the electrokinetic potential (the potential existing across the Helmholtz double layer) can be measured for an oil-aqueous solution interface using streaming potential technic. In its essential features the method consists of immersing two insulated platinum electrodes in a volume of oil and streaming a "rod" of water through a pin hole in one electrode so it passes through the oil and impinges upon the opposite electrode, imparting to it an electric charge. The difference in potential between the electrodes is then measured by means of a quadrant electrometer. The E.M.F. measured was found to be proportional to the hydrostatic pressure under which streaming was induced. The temperature coefficient of the potential was found to be appreciable. Potential curves were determined for the systems; refined paraffin oil (Nujol) and various concentrations of aqueous solutions of NaCl, $CaCl_2$, $ThCl_4$ and sodium stearate. Sodium stearate, sodium chloride and calcium chloride increased the electrokinetic potential at the interface in solutions of low concentrations, sodium stearate solutions being particularly effective. Higher concentrations reduced the potential somewhat. Thorium chloride solutions reduced the potential and reversed the charge from (−) to (+). The electrokinetic potential curves at oil-aqueous solution interfaces closely resemble electrokinetic potential curves at cellulose-aqueous solution interfaces or glass-aqueous solution interfaces. The measured potentials do not parallel interfacial tension changes.

Equilibrium theory of the cathode spot in mercury arcs: KARL T. COMPTON. The following considerations yield some definite information regarding the fraction of the current at the cathode of a mercury arc which is carried by electrons and show that the temperature of the cathode spot is so low that the electron emission can not possibly be of thermionic origin. The results therefore are in support of Langmuir's theory according to which the electron current from the cathode is a field current of electrons which are drawn out by the intense field concentrated there by the positive ion space charge. Four years ago Dr. Van Voorhis and the author presented to the academy a theory of the heat balance at the cathode. This theory is now extended by evaluating factors regarding which there was then insufficient knowledge. There are eight principal ways in which heat is fed into or taken away from the cathode. All these are now evaluated except for uncertainty in two quantities, one being the fraction of positive ions produced near the cathode which move, contrary to the applied voltage, toward the anode, and the other is the accommodation coefficient which measures the fraction of kinetic energy of a positive ion impinging on the cathode, which is delivered to the cathode. One equation which does not involve either of these unknown quantities gives a lower possible limit to the fraction of current carried by electrons. The other equation, which involves these two unknown quantities, gives an actual value for this fraction. Certain experimental evidence regarding these unknown quantities leads to the conclusion that the fraction of current carried by electrons at the cathode is certainly considerably in excess of 0.80. By applying equations of kinetic theory of gases to the observed rate of evaporation of mercury from the cathode spot, an equation relating vapor pressure to temperature at the surface of the cathode spot is obtained. By comparing this equation with the ordinary vapor pressure temperature relation for mercury vapor, unique values are found for the temperature of the cathode spot and the vapor pressure immediately outside it. These values depend on the value of the fraction of current carried by electrons, but the permissible values of this fraction show that the temperature of the cathode spot can not be higher than about 200° Centigrade. A consideration of the mechanism of ionization and of the pulling of electrons out of metals indicates that the ionization near the cathode must be of the cumulative type in which an atom is ionized by successive impacts of at least two electrons. These considerations enable us to plot a potential distribution curve for the region near the cathode which appears to be constant with all known facts regarding the mercury arc, although the distance scale on which this diagram is drawn can be fixed only between upper and lower limits. This theory appears to be equally applicable to the small mercury arc, such as that used for illumination and for the very large arcs now used in the metal tank rectifiers for electric railway operation.

Electron lenses: C. J. DAVISSON and C. J. CALBICK.

X-ray scattering by gases and atomic structure: E. O. WOLLAN and A. H. COMPTON. Measurements have been made of the intensity of the x-rays scattered at different angles by hydrogen, helium, oxygen, neon and argon. From these measurements the electron distributions in the atoms of helium, neon and argon have been found. For scattering by oxygen, neon and argon, a wavelength of $\lambda = 0.71$A, obtained by Ross' double filter method, was used. For hydrogen and helium it was necessary to use a single filter and an effective wavelength of 0.50A to get sufficient intensity. The scattering by the various gases was compared with that by hydrogen at 90 degrees, whose intensity can be reliably calculated. Electron distributions are calculated from these data for helium, neon and argon, using a straightforward application of Fourier integrals. The results can not be reconciled with Schrodinger's early interpretation of $\psi\psi^*$ as representing a continuous distribution of electricity, but are in excellent accord with the quantum mechanics predictions if $\psi\psi^*$ is interpreted as a probability of the occurrence of electrons.

Atom building in steps: W. D. HARKINS.

The rise of man and modern research: JAMES H. BREASTED.

Biographical memoir of John Fillmore Hayford (read by title): WILLIAM H. BURGER.

Biographical memoir of Stephen Alfred Forbes (read by title): L. O. HOWARD.

Biographical memoir of Ira Remsen (read by title): WILLIAM ALBERT NOYES and JAMES FLACK NORRIS.

Biographical memoir of Frank Austin Gooch (read by title): RALPH G. VAN NAME.

Biographical memoir of Thomas Burr Osborne (read by title): HUBERT BRADFORD VICKERY.

Biographical memoir of Robert Ridgway (read by title): ALEXANDER WETMORE.

Report of the National Academy Committee on the Grand Canyon project: JOHN C. MERRIAM.

Regarding definition of problems which concern evolution of man: JOHN C. MERRIAM.

The discharge of hot springs in the Yellowstone Park: E. T. ALLEN. As a part of an investigation in the Yellowstone Park, carried on by a Geophysical Laboratory during the last six years, an attempt was made in 1930 to determine the aggregate discharge of water from the hot springs of this famous locality. The value obtained is regarded as a first approximation which may safely be compared with the volume of the cold drainages and with the measured discharge of other hot springs districts. In one important hot spring group, a long series of accurate measurements enables us to draw satisfactory conclusions regarding the constancy of the discharge. In another large basin the measurements, while fewer and less accurate, leave no doubt concerning the same question. The magnitude of the discharge in spring groups of different type is strikingly different. Inasmuch as the volume of the water is held to be a factor of first importance in the development of each type, this result has a special interest. From the values for the discharge and numerous analyses of the waters the magnitude of the dissolved mineral matter carried away by the water has been computed.

Fundamental scientific data resulting from geodetic surveys: WILLIAM BOWIE. The geodetic work of the Coast and Geodetic Survey has as its primary purpose the furnishing of geographic positions and elevations of thousands of points along the coasts and over the area of the interior of the United States as the bases for charts, maps, surveys, and many other engineering operations. The data resulting from these surveys are also of fundamental importance in science. It is by means of geodetic measurements of distances and angles and astronomical determinations of latitude and longitude that the figure of the earth can be determined. We know the figure of the earth, that is, its dimensions and shape, with a high degree of accuracy, but science is always striving for perfection. We have, in North America, connected geodetic surveys covering the United States and portions of Mexico and Canada, which will, in the near future, be used for a new determination of the earth's dimensions. The new value should have even greater strength than previous ones. By means of geodetic data, isostasy has been proved to be a scientific principle. According to this principle the irregular surface of the earth is due to varying densities in the crust below. Under the continents the material is less dense than it is under the oceans. The space within which these varying densities occur is limited by a level surface approximately 60 miles below sea level. The proof of isostasy leads to the definite conclusion that the interior of the earth is composed of material that is plastic to long-continued stresses. The geodetic data furnish a means by which varied structure, at least in its general outlines, can be discovered. This makes geodetic data of economic importance in searching for minerals. The accurate determination of geographic positions and elevations by geodetic methods enables one to test the stability of the earth's surface in any given region. The accuracy of the leveling, by which elevations are determined, is such that a closed loop of leveling has an error seldom greater than at the rate of 0.2 of a millimeter per kilometer of the distance around the circuit. In the triangulation, by which the geographic positions are determined, distances can be measured across country with an accuracy of one part in from two to four hundred thousand. It is readily seen that by repeating the observations from time to time the geodetic engineer can disclose any movements in position or elevation of the established stations. This method has been employed in California to detect what changes in geographic positions occurred at the triangulation stations near the San Andreas fault. This same method has been employed extensively in Japan to detect earth movements during earthquakes there. The observations made at the Variation of Latitude Stations at Ukiah, Calif., and Gaithersburg, Md., in connection with similar observations at stations in other countries, furnish data of fundamental importance to the science of astronomy. From the resulting data secured at these stations an estimate can be made of the rigidity of the earth. The triangulation and leveling of the United States are progressing rapidly. It is expected that the first and second order triangulation and leveling will be completed in the next twelve years. When this is done there will be few, if any, places in the country more than about 25 miles from a first or second order triangulation station or leveling bench mark. Intermediate areas will be covered by geodetic surveys of a lower order as the topographic mapping progresses. This expanded program of geodetic work of the U. S. Coast and Geodetic Survey is due to the initiative of President Hoover, who recommended to Congress that funds be provided for more rapid operations.

The physical basis of modern hydrographic surveying: A. L. SHALOWITZ (introduced by William Bowie). The

Great War was not only a landmark in the political and economic affairs of the world, but it marked, as well, the dawn of a new era in the application of the physical sciences to the problems of the hydrographic engineer. The possibility of utilizing sound as a means of measuring ocean depths and distances had been recognized long before this period, but no practical method had been evolved for meeting the exacting demands of modern hydrographic surveys. The investigations made during the war were quickly focussed on peace-time needs by the various maritime nations, resulting in this country in the development of the sonic depth finder by the U. S. Navy and later the fathometer by the Submarine Signal Corporation. With the development of sonic sounding came the Radio Acoustic Method of Position Finding, by means of which the positions of soundings are determined by measuring the time interval for a sound impulse to travel from the surveying vessel to two or more predetermined hydrophone stations near shore or at suitable points offshore. The application of acoustic principles to hydrographic surveying has been responsible for the rapid progress made by the Coast and Geodetic Survey, in the last few years, in the accurate and detailed charting of the waters along the Pacific Coast, and has made practicable the enormous Georges Bank undertaking. Through the instrumentality of the echo-sounding machine, an uncharted submarine valley, two miles wide, eight miles long and 1,800 feet deep, has been discovered on this bank, directly in the westbound transatlantic steamer lane and ideally oriented for vessels reshaping their course for Nantucket Light Ship. The paper discusses some of the problems entering into the acoustic method of surveying and shows the desirability and importance of knowing the path followed by the sound wave in its journey from the bomb to the hydrophone, particularly in an area where it is not feasible to determine the velocity of sound by direct methods. The paper presents the results of a study of the relationship between experimentally determined velocities of sound and theoretical velocities based on surface, mean and bottom temperatures of the water. The investigation indicates that the peak of the sound energy that reaches the hydrophone has been affected by physical conditions closely analogous to that obtaining at the bottom layers of water between the bomb and hydrophone. While the conclusions reached are by no means presented as a final product, this theory of sound-wave propagation, if substantiated by further experimental data, will have a far-reaching effect on future surveying operations and investigations.

The colloid chemistry of insanity: WILDER D. BANCROFT and G. HOLMES RICHTER. Insanity can be produced by suitable administration of peptizing agents or of coagulating agents. There are therefore two kinds of insanity, one in which the colloids of the brain are over-peptized and the other in which they are over-coagulated, insanity occurring when the brain colloids are far enough removed from the normal state. The coagulation form of insanity can be helped by treatment with dispersing agents, such as bromides or thiocyanates. The dispersion form of insanity can be helped by treatment with coagulating agents, such as cocaine or amytal. Probably caffeine would be still better.

Chemical structure and optical activity: P. A. LEVENE and R. E. MARKER. Previous observations of this laboratory have led to the conclusion that in simple substances of the type $\mathrm{H{-}\overset{\displaystyle R_1}{\underset{\displaystyle R_2}{C}}{-}OH}$ the direction of the rotation is determined by the respective weights of the radicles R_1 and R_2. When in the arrangement of Fig. 1, $R_1 > R_2$ the substance is dextrorotatory. If R_1 is replaced by a polar group, as –COOH, then the latter group determines the direction of rotation and all substances of the type $\mathrm{COOH{-}\overset{\displaystyle OH}{\underset{\displaystyle H}{C}}{-}R}$ are levorotatory. It was now found that the group $\mathrm{-CH\langle^{CH_3}_{CH_3}}$ has an effect similar to a polar group and that the character of its effect is altered by the distance which separates it from the asymmetric carbon atom so that the members of the two configurationally related series of carbinols, *i.e.*, $\mathrm{{}^{CH_3}_{CH_3}\rangle CH{-}\overset{\displaystyle OH}{\underset{\displaystyle H}{C}}{-}R}$ and $\mathrm{{}^{CH_3}_{CH_3}\rangle CH{-}CH_2{-}\overset{\displaystyle OH}{\underset{\displaystyle H}{C}}{-}R}$ rotate in opposite directions.

It has been found further that in the case of hydrocarbons of the type $\mathrm{H{-}\overset{\displaystyle R_1}{\underset{\displaystyle R_2}{C}}{-}CH_3}$ the direction of the rotation is determined by the respective weights of the groups R_1 and R_2. The changes in the numerical values of the rotations of individual members have been found to vary according to the rule of the "asymmetry product" enunciated by Guye so that in homologous series of hydrocarbons the direction and the numerical values of the rotation are predictable. In the case of hydrocarbons the effects of the isopropyl and of the isobutyl groups are analogous to those in the case of the carbinols. In a general way the conclusion has been reached that the rotation of a given substance is determined in the simplest case by the distribution of masses around the asymmetric carbon atom. In the more complicated cases when a polar group enters into the structure of a molecule the rotation is determined (1) by the respective weights of the masses surrounding the asymmetric carbon atom; (2) by the effect of the polar group, and (3) by the distance of the polar group from the asymmetric carbon atom.

The heat of combustion of methyl alcohol: FREDERICK D. ROSSINI (introduced by George K. Burgess). Be-

cause of its importance in the study of the equilibrium conditions of the reaction involving the synthesis of methyl alcohol from carbon monoxide and hydrogen, and because of the discordant nature of the existing data, the heat of combustion of methyl alcohol has been measured. In the present investigation methyl alcohol was burned at constant pressure in a reaction vessel in the calorimeter, and the thermal effect produced by the reaction was duplicated as nearly as possible with electrical energy. For the heat evolved in the reaction, $CH_3OH(g) + 3/2\,O_2(g) = CO_2(g) + 2H_2O(l)$, at 25° C. and a constant pressure of 1 atmosphere, the data of 9 experiments give the value of 763.77 ± 0.20 int. kilojoules per mole. Combining these data with those of Flock, Ginnings and Holton on the heat of vaporization of methyl alcohol, gives, for the heat evolved in the reaction $CH_3OH(l) + 3/2\,O_2(g) = CO_2(g) + 2H_2O(l)$, the value 726.34 ± 0.20 int. kilojoules per mole at 25° C., 1 atmosphere. With the factor $\frac{1.0004}{4.185}$ these heat values are respectively 182.58 ± 0.05 and 173.63 ± 0.05 kg-cal.$_{15}$ per mole. The value given by Richards and Davis is 1.5 per cent. lower than the present one, while the recomputed data of Thomsen give a value in agreement with it, within the assigned limits of error.

Form factors in types of fish skulls: WILLIAM KING GREGORY. The study of over 200 different types of fish skulls leads the author to the conclusion that there is undoubtedly a regulating influence that adjusts the size and proportions of the head to those of the body as a whole in such a way that a stream-line normally results. The skull is subjected primarily to the growth forces that mould the body as a whole and these general growth forces affect the individual bones that lie in their paths; but the parts of the head themselves also have a degree of influence on the form of the skull; as each pair of main sense organs becomes enlarged or reduced, the corresponding parts of the skull change with them. The changing characters of the jaws and branchial arches have had profound effects upon the form of the braincase and the changing positions of the mouth in different types of fishes have had a great effect upon the jaw bones and the skull.

Contributions to North American herpetology; the frogs: ALBERT HAZEN WRIGHT and ANNA ALLEN WRIGHT (introduced by Leonhard Stejneger).

A new application of metaxenia through differential pollination: W. T. SWINGLE (introduced by R. A. Harper).

The character and inheritance of developmental differences in fruit shape: EDMUND W. SINNOTT (introduced by C. E. Allen). It has been shown that fruit shape in various plants is determined by genetic factors which are inherited independently of those governing volume or dimensions. These shape factors presumably control growth correlations. Their character and method of inheritance have thus far been studied chiefly by an analysis of differences in the shape of mature fruits. An investigation of fruit development, however, from ovary primordium to maturity, shows that there are marked differences in the manner by which fruit shape may be attained. Various pure lines, differing in fruit shape, were studied in *Cucurbita Pepo* and *Capsicum annuum.* In Cucurbita the shape index of the mature fruit is in most cases not widely different from that of its ovarial primordium, but in certain lines the fruit becomes progressively somewhat flatter as it develops. If shape index is plotted against volume, various inbred lines manifest marked and specific differences in the character of the curve produced. This may be essentially a straight line, differing only in pitch in different races; or it may shew distinct concavities, the character and depth of which are also highly specific. In general, the slope of this curve is steeper in races which have a relatively "flat" fruit shape. Certain lines, between which the major shape difference is due to a single genetic factor and which are also clearly different in the slope of their developmental curves, were crossed. It was found that the F_1, whatever its shape index, was usually intermediate in the slope of its curve, and that the members of each of the two segregating shape types in the F_2 showed a considerable variability in the slopes of their developmental curves. Other lines, essentially similar both in shape index and in development, differ markedly in the ability to transmit their specific developmental characters to their progeny in crosses with other lines. Crosses between two lines each showing relatively flat developmental curves may produce offspring with markedly steeper ones. Capsicum differs from Cucurbita in that the ovarial primordia in all types are very similar. The growth of the flat, the isodiametric and the elongate fruit types from these primordia involves profound developmental differences. An understanding of the manner in which genetic factors determine fruit shape must evidently depend upon a study not only of the mature structure itself but also of the changes undergone during its developmental history.

Stimulation by alcohol: W. J. V. OSTERHOUT and S. E. HILL. Alcohol is able to produce electrical changes in plant cells and hence to start and stop action currents: it therefore acts as a stimulus and as a block.

The effects of deprivation of manganese on the rat:[1] E. V. MCCOLLUM and ELSA R. ORENT. Rats restricted to a diet which is essentially free from manganese grow normally. They begin to produce litters at the normal age. The young are born alive. The mothers do not build a nest or collect their young or hover over them, and the stomachs of day-old young never contain any milk, and the young die from neglect. Vaginal smears show that the adult females go through the normal estrual cycle and if kept with normal males their fertility approximates that of normally fed rats. These mothers with one exception declined to nurse their own young and did not care for foster young from the stock colony.

[1] From the Department of Chemical Hygiene of the School of Hygiene and Public Health of the Johns Hopkins University, Baltimore, Maryland.

In tests with about one hundred young from manganese-free mothers only one animal was reared by stock females which had just delivered litters, whereas exchanging young of stock mothers does not result in lack of maternal solicitude. It appears that the normal mother detects something wrong with the young of manganese-free mothers and abandons them. This happens even when the young of manganese-free mothers are wrapped in cotton with normal stock litters of new-born for an hour or more for the purpose of putting the odor of each kind of young on the other before placing them with the stock mothers. Histological studies are being made of the mammary tissue at different stages of gestation, to determine whether there is any development preparatory to milk secretion. The addition to the manganese-free diet of as little as five thousandth of one per cent. of manganese results in preventing the behavior of the female rats toward their young. With this addition they care for their young normally and have almost no infant mortality. Male rats kept on a manganese-free diet show no abnormality other than testicular degeneration. This degeneration is well under way by the hundredth day on the diet. The atrophy then rapidly proceeds until only vestiges remain and complete sterility results. The histological changes at different stages of degeneration of the testes will be described later. There is little or no tendency to obesity in these males. The testicular atrophy and the failure of females to suckle young suggest failure of some hormone production in the hypophysis. There is a clinical literature on male sterility developing in middle life, which is referred to hypophyseal deficiency. There is likewise recognized by endocrinologists a stimulating effect on milk secretion caused by the administration of certain hypophyseal extracts. Observations thus far made seem best explained on the theory that manganese is in some manner related to hormone formation by the hypophysis. The problem is being studied in detail.

New methods for locating genes in particular chromosomes: ALBERT F. BLAKESLEE. The usual method of locating genes is by linkage between two or more genes in disomic inheritance. The newer methods developed in Datura include the following: (1) All the 12 primary $(2n+1)$ types when heterozygous for a given gene throw disomic ratios in their offspring except the type whose extra chromosome carries the locus for this gene. This latter primary throws trisomic ratios. By trisomic ratios from $(2n+2/2)$ secondary types, from $(2n+1)$ tertiary types with a compound chromosome extra, and from extra fragment types, genes may be located in particular parts of chromosomes. (2) Compensating types, in which parts of two chromosomes compensate to form the equivalent in genic content of a whole chromosome, if heterozygous for a gene with its locus in the compensated chromosome will breed true for this gene among its 2n offspring, except for crossing over. Double compensating types are known which compensate for two different chromosomes. (3) Types with a translocated fragment, which enables the plants affected to be recognized by external characters, if heterozygous for a gene with its locus in the chromosome to which the fragment is translocated, will breed true for this gene among its 2n offspring, except for crossing over. (4) Prime types (types with chromosomes modified by segmental interchange) if they induce a definite proportion of aborted pollen in the heterozygous condition may be used to locate genes by ratios of individuals in the offspring with good to those with characteristic percentages of aborted pollen. This method locates the gene in one of two chromosomes if the prime type has two chromosomes modified. (5) If a plant heterozygous for a gene which causes abortion of one half the pollen grains but which does not affect the vitality of the egg cells is rendered heterozygous for a non-lethal gene, all the offspring from the male back-cross will be homozygous for the gene, except for crossing over. In the usual method of locating genes by linkage, the crossing-over values are determined by the interaction of two genes with loci in the same chromosome. By the methods 1, 2, 3 and 4, here given, the crossing over of a given gene can be determined without regard to the behavior of a second gene.

A new travertine-forming organism: MARSHALL A. HOWE. The geological importance of certain aquatic plants known in a general way as the algae has received increasing recognition during the past twenty-five years. Not only have certain so-called "coral" reefs been found to have been built up by lime-secreting plants rather than by lime-secreting animals, but many fresh-water deposits of lime, both recent and fossil, have been found to be due chiefly to the peculiar activity of minute plants belonging to the group known as the blue-green algae. The speaker described in particular a very minute lime-precipitating organism of bacterial dimensions that is responsible for the formation of concentrically layered pebbles and sometimes more extensive deposits of limestone that occur in "hard-water" streams of Pennsylvania and West Virginia. This organism, geologically important, is believed to be new to science.

(*To be continued*)

BOOKS RECEIVED

BLANCHARD, W. O., and S. S. VISHER. *Economic Geography of Europe.* Pp. ix + 507. 331 figures. McGraw-Hill. $3.50.

CHAMOT, ÉMILE M., and CLYDE W. MASON. *Handbook of Chemical Microscopy.* Volume II, Chemical Methods and Inorganic Qualitative Analysis. Pp. ix + 411. 181 figures. Wiley, $4.50.

HACKH, INGO W. D. *Structure Symbols of Organic Compounds.* Pp. viii + 139. 29 plates. Blakiston.

MEIER, W. H. D., and LOIS. *Essentials of Biology.* Pp. vii + 529. 332 figures. Ginn. $1.68.

MILLER, EDWIN C. *Plant Physiology.* Pp. xxiv + 900. 38 figures. McGraw-Hill. $7.00.

SIMONSEN, J. L. *The Terpenes.* Volume I, The Simpler Acyclic and Monocyclic Terpenes and their Derivatives. Pp. xv + 420. Cambridge University Press, Macmillan. $8.50.

SMALLWOOD, JULIAN C., and FREDERIC W. KEATOR. *Mechanical Laboratory Methods.* Fourth edition. Pp. xii + 386. 121 figures. Van Nostrand. $3.50.

STRECKER, EDWARD A., and FRANKLIN G. EBAUGH. *Practical Clinical Psychiatry for Students and Practitioners.* Third edition, revised. Pp. xvii + 553. 47 illustrations. Blakiston.

SCIENCE

VOL. 73 FRIDAY, MAY 15, 1931 No. 1898

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE UNION OF AMERICAN BIOLOGICAL SOCIETIES AND BIOLOGICAL ABSTRACTS

THE WASHINGTON CONFERENCE OF MARCH 7, 1931

By Professor W. C. CURTIS

PRESIDENT 1931

THE Union of American Biological Societies was formed in 1923 by the organizations that wished to establish the comprehensive abstracting journal known as *Biological Abstracts.* It is stated in the preamble of the Union that "in view of the existence of many biological societies in America, each preoccupied with its own special affairs and problems, in view of the assured interest of all these societies in the broader and more general aspects of the promotion of biological science, and especially in view of the need for improved means of contact and mutual aid between the pure and the applied branches of biological science, this Union is established to facilitate constructive and mutually advantageous cooperation among the several special biological societies and to promote the major interests of biology." The objects stated are "to stimulate investigation in the field of biology, to organize and promote the interests of bibliography and publication, to deal with questions of general interest in the field of biology, and in general to promote the solution of those broad problems which the specialized societies are not in a position to support effectively, and to do anything else which may serve these ends."

Administration of the Union is vested in an executive committee, consisting of the president, secretary, treasurer and three additional members, and a council, consisting of two representatives of each member-society. At the outset there were seventeen member-societies. There are now twenty-nine, with another

to be added within the year. When the magnitude of the Union's initial enterprise, *Biological Abstracts*, was appreciated, it was decided that other major responsibilities should not be undertaken until the *Abstracts* could be firmly established. For this reason the Union has been inactive, except as its sponsorship and its representation on the trustees of *Biological Abstracts* have been of inestimable value to this publication. As the membership is by societies and not by individuals, the Union is unknown to many American biologists, and some who participated in its organization may have forgotten its existence.

The need for such an organization as the Union is apparent. American chemists have about 18,000 members in one organization, the American Chemical Society; we biologists have about 8,500 different individuals distributed among thirty societies. Any biological enterprise of broad significance must be undertaken by a number of these thirty organizations. This situation may be unfortunate, but it is an accomplished fact resulting from group interests that have created stimulating units of discussion and cooperation in the biological field. It is idle to say that such disruption might have been prevented, if some of the older biological organizations, like the American Naturalists, or if the American Association for the Advancement of Science had dealt more wisely with the diversified interests of their membership on many occasions. It seems to the writer no less idle to suppose that any one of the older societies can now provide the necessary mechanism if we are to unite for major undertakings. If any form of organization can be effective for these activities, it will be a federation, like the Union of American Biological Societies, into which each society comes as an equal. One may indeed despair of success in the cooperation of groups so diversified. Democracy is like a raft—"it never sinks, but our feet are always wet." As it stands the Union of American Biological Societies may be only a "paper organization," but it represents a commitment and a great accomplishment. The members of its constituent societies approved the establishment of *Biological Abstracts* by an overwhelming majority in a referendum taken before the initiation of this publication, and our hopes are near to realization. Having set our hands to the plough we can not turn back until the *Abstracts* is placed upon a secure foundation. If the Union succeeds in this undertaking it may be deemed worthy of other responsibilities.

As *Biological Abstracts* is now confronted with the problem of more permanent financing, it seemed desirable that effective consultation be held with the member-societies. The council of the Union, consisting as it does of two representatives elected by each society, presented the normal method of such contact. But the expense of bringing fifty-eight individuals together was a serious obstacle. Moreover, the present membership of the council was elected some years ago. It seemed most important that the executive committee should consult the present officers of the member-societies. Conferences held at the time of general scientific meetings, as at Cleveland last December, are seldom effective as to attendance or discussion. It was, therefore, decided to hold a conference between the executive committee of the Union and the presidents of all member-societies, or representatives these presidents might delegate, at a time when other interests were not impending. It was felt by the executive committee of the Union that the traveling expenses of individuals attending such a meeting should be borne by their respective societies, but knowing the budgets of these organizations it was obvious that such financing would be impossible on short notice. As the need was for a fully representative meeting at an early date, we arranged with the National Research Council for payment of these expenses.

As a result, forty individuals were present in Washington March 7, and all but two of the twenty-nine member-organizations were represented. The discussion begun at the three-hour morning session was continued at luncheon and thirty-five were still present when the conference adjourned at 5:00 P. M. It was thus as representative a meeting as could be expected under the circumstances, and the executive committee of the Union feels that the sense motions of such a conference should be highly regarded. The conference was opened with remarks by the president of the Union, the substance of which is included in the preceding paragraphs. Professor McClung, the past-president, and Dr. Schramm, editor-in-chief of *Biological Abstracts*, then spoke informally, after which the meeting was thrown open for discussion of the *Abstracts* and problems of the Union.

As the purpose of the gathering was to inform those in attendance regarding the editorial and financial problems of *Biological Abstracts*, and incidentally to discuss what might be done by its sponsors, the Union was discussed mainly in relation to its commitment, the *Abstracts*. Questions and criticism were invited rather than polite approval. It was evident that the individuals in attendance were appreciative of *Biological Abstracts* and that criticism was directed, not at the undertaking itself but at its incompleteness, the delays in indexing and similar limitations to date. As the editorial and financial problems became more familiar during the discussion, these criticisms became wholly sympathetic. It seems fair to say that those in attendance left Washington

much more impressed by what had been actually accomplished in the stupendous task of abstracting all biological literature than by the delays, since these have been inevitable where problems of such magnitude have arisen and funds have been inadequate despite generous assistance.

As the executive committee of the Union wished that opinions and other expressions should represent judgments based upon the information presented at the meeting and upon adequate examination of documents submitted with the agenda, no formal resolutions were proposed. Instead, we mailed to each individual during the week following the conference the questions cited with summary of replies in the following paragraphs.

(1) *Do you endorse Biological Abstracts?—*

(a) as a worthy accomplishment to date.

(b) as a project that should be completed in the sense that abstracts and indices be brought up to date as soon as possible.

(c) as an integrating factor in the biological sciences.

(d) as potentially an invaluable aid to investigation.

Yes: 30, many adding a commendatory sentence.

2, with reservations.

1, would prefer *Botanical Abstracts* as published before its merging with *Biological Abstracts.*

(2) *Do you favor inclusion of systematic literature as an integral part of Biological Abstracts?*

Yes: 20, some with strong commendation of such inclusion.

6, yes, with some reservation, like "if not too expensive."

Uncertain: 5, because not interested in the field.

No: 2.

This question was discussed at length by the conference. A large majority evidently felt that the inclusion of taxonomic abstracts is highly desirable.

(3) *Do you favor publication of indices annually or at less frequent intervals, say, every five or ten years?*

Annually: 32, many with emphatic comment to effect that annual and also cumulative 5 or 10-year indices are necessary.

5-year-intervals: 1, although desirable annually if not too expensive.

As discussed in the conference it was clear that the group was virtually a unit in its conviction that the annual index is an indispensable part of the *Abstracts.*

(4) *Do you endorse solicitation by trustees of Abstracts and officers of the Union of additional financial support to bring up to date within a two-year period the editorial work of abstracting and indexing and of publication?*

Yes: 32, many with comments that the only strictures that can be fairly passed upon *Biological Abstracts* to date are the failures resulting from inadequate financial support.

No: 1, the botanist who again expresses wish for a return to *Botanical Abstracts.*

(5) *What do you regard as the greatest accomplishment of Biological Abstracts to date?*

The answers are naturally diverse, but all reflect the conviction that the accomplishment to date is a remarkable achievement, despite any shortcomings. One comment that expresses essentially that of many others is: "Organization of a working machine that may be expected with proper support to bring the world's biological literature to the hands of investigators more effectively than any or all other agencies."

(6) *What do you regard as the greatest shortcoming in Biological Abstracts to date?*

Incompleteness and delays in publication are cited by the majority, but these defects are recognized as inevitable at the outset and with limited financing. Delayed indices are frequently cited. Criticism therefore centers principally upon defects that have resulted from financial limitations, which make payment of honoraria, earlier printing, etc., impossible.

(7) *Are you willing to present the case of Biological Abstracts as opportunity offers to other members of the biological society or societies in which you hold membership?*

Yes: 29, some adding strong comments.

No answer: 3.

No: 1, who previously expressed preference for *Botanical Abstracts.*

(8) *Do you regard as thoroughly justified the expenditure of one dollar on the adequate and comprehensive abstracting and indexing service in biology for every \$1,000 to \$2,500 expended on the research thus abstracted and its original publication?*

Yes: 30.

Yes: 3, with reservations, like "if it costs that much."

(9) *Have you any suggestions regarding immediate activities of the Union of American Biological Societies other than its support of Biological Abstracts?*

This question of what other activities might be undertaken by the Union was discussed briefly before the conclusion of the conference. It was not pressed by the executive committee, because of the action taken by the council of the Union excluding other major enterprises until *Biological Abstracts* can be well established. A number suggested concerted action toward more effective publication of research in view of the enormous number of titles that appear annually in the biological field. Professor C. W. Greene presented briefly for information of the conference a proposal for federal aid to basic scientific research that is being submitted to various scientific bodies during the present year. From the discussion of the Union and its functions it was evident that

no other undertaking of such importance as *Biological Abstracts* is attracting the attention of American biologists. There was, however, no disposition to shift responsibility for the *Abstracts* to some other organization. The conviction of the executive committee that the Union "must be preserved," at least until *Biological Abstracts* is permanently financed, and that other activities may wait upon future demands seemed to be that of the conference.

As the original financing of the Union is about exhausted, the conference discussed methods of raising money for advertising within the member-societies and otherwise promoting the interests of *Biological Abstracts*. The matter was referred to the executive committee for further discussion with officers of the societies. This advertising looks toward an increase in the subscription list of the *Abstracts*. Such an increase must occur if we expect to convince those who can provide for editorial costs that *Biological Abstracts* has the unquestionable support of biologists, not only in America, but in other countries, since it is an international enterprise.

BIOLOGICAL ABSTRACTS

By Dr. J. R. SCHRAMM

EDITOR-IN-CHIEF

ABOUT May 1, 1931, the funds in the original grant from the Rockefeller Foundation for the editorial conduct of *Biological Abstracts* will have been exhausted. Very recently (December 1 of last year) a continuing grant for two years was made by the Foundation. The present therefore marks the approximate close of the preliminary chapter in the development of *Biological Abstracts*, and it is thus appropriate that a report be made on the status of the undertaking. It will be well at the outset to outline the facts upon which the project was predicated.

Biological articles of a research character number at present over 50,000 a year. They are published in some 6,000 serials and in over twenty-five languages. They cover annually hundreds of thousands of pages, and cost millions of dollars a year to publish.

There exists no system of distribution of manuscripts by subjects to specific research journals. Even were such a plan devised it would soon be rendered ineffective by the rapidly changing character of the subject.

The necessity under these circumstances of instruments of orientation in the literature is obvious. With the phenomenal growth of the literature in biology, especially in this century, these have increasingly taken the form of abstracting journals in more or less highly specialized fields and are rendering great service.

Increasing specialization has brought with it, however, a corresponding insistent problem of synthesis; wholes have to be constructed from larger and larger numbers of smaller and smaller parts. For this purpose the highly specialized abstracting journal is less well adapted, for important progress in one field frequently springs from advances or suggestions from another, even a remote one, resulting in the intimate linking of fields considered relatively unrelated. Also, between highly specialized abstracting journals extensive duplication is unavoidable.

Among striking examples of such integration may be mentioned: genetics and cytology, and between these subjects and systematics; plant and animal pathology and parasitology on the one hand, and entomology on the other, especially through the rôle of insects as pathogen vectors; cytology on the one hand, plant and animal pathology on the other; public health administration and systematics of disease vectors, *e.g.*, fleas, mosquitoes, etc.; economic entomology and plant ecology; protozoology and pathology; anatomy and physiology; serology, biochemistry and biophysics on the one hand, phylogeny on the other; bacteriology and plant pathology; systematics of poisonous animals and serum therapy, etc., etc.

Such changes, often abrupt, are largely unpredictable and frequently lead to marked changes in emphasis and give new direction to research endeavor. These developments are indicative of an increasing integration in which the various biological disciplines, not infrequently characterized by more or less isolation and lack of mutual understanding, are converging and each making substantial contributions to common problems.

Also, there is a growing realization that applied fields prosper best when firmly rooted in the more theoretical disciplines underlying them. That this association is fruitful to the theoretical fields as well is evident in the wealth of suggestions and problems contributed and in the vigorous personnel recruited.

The problem has its important economic aspects. Under a system of numerous specialized abstracting journals, it is not uncommon to find institutions expending annually from $300 to $800 and more on abstracting journals in biological subjects, though leaving considerable fields almost untouched. Prices of individual specialized journals have reached a

point in most cases entirely beyond the reach of individuals, annual subscription rates with few exceptions ranging from twenty-five to seventy-five dollars and more. In contrast to this state of affairs is the situation in chemistry, where admirable single comprehensive services, *e.g., Chemical Abstracts,* are available at a small fraction of the cost for comparable services in biology, thus keeping such instruments within the reach not only of institutions but of individuals as well.

How, then, are the workers in the diversified but increasingly interdependent science of biology to be kept in contact with the literature to best serve its immediate and changing needs and to provide the most favorable conditions for its sound growth?

Dr. McClung has summarized the study of this problem by the Joint Publications Committee of the Union, the Division of Biology and Agriculture of the National Research Council, and the American Association for the Advancement of Science, which resulted in the recommendation to establish a single comprehensive abstracting journal for theoretical and applied biology exclusive of clinical medicine. Besides this basic recommendation, the report of the Joint Publications Committee contained the following major items, based upon the literature of 1921 and conditions as existing in 1922–1923:

1. Number of titles annually in theoretical and applied biology exclusive of clinical medicine, approximately 40,000.
2. Number of pages required to cover this literature (40,000 titles) in one or more abstracting journals (assuming that there were no duplications) on the basis that 6.8 titles could be cared for per page, about 6,000.
3. Cost of manufacture of 6,000 pages of abstracts plus 500 pages of indexes (estimated) in an edition of 7,000, \$58,000.
4. Subscriptions:
   a. It was estimated that 1,000 subscriptions could be secured to such a comprehensive journal at \$15.00 annually—\$15,000.
   b. This leaves \$43,000 to be carried by individual subscriptions and advertising. Should each member (total 6,000) of the societies adhering to the Union eventually support the journal, as the members of the American Chemical Society support *Chemical Abstracts* through their society dues, the cost to the individual would be \$7.16 (assuming that all editorial overhead were met in other ways).
5. Editorial cost of caring for 40,000 papers annually on a non-honorarium basis, \$75,000.

This report was adopted by the Union and by the Division of Biology and Agriculture of the National Research Council, with authorization to seek funds for putting the recommendations into effect.

Although the report was the result of a long study and had the approval of both the Union and the National Research Council, it was submitted to biologists individually in a general referendum, receiving a favorable vote by from 83 to 97 per cent. of the voting membership of the twenty-odd member societies of the Union.

With this mandate, and after extensive discussions with European biologists, the Union, with the active cooperation of the National Research Council, sought and secured funds for the editorial conduct of the abstracting service, the cost of printing and business management to be defrayed out of subscription, advertising and other income. In November, 1924, \$350,000 was made available by the Rockefeller Foundation over a period of ten years, not to exceed \$50,000 to be expended in any one year. The National Research Council has acted as repository for the current funds, and has disbursed them on requisitions and vouchers approved by the editor-in-chief of *Biological Abstracts,* the president of the board of trustees of *Biological Abstracts,* and the chairman of the Division of Biology and Agriculture of the National Research Council. There are thus on file in the office of the treasurer of the National Research Council the complete official audited accounts representing the expenditure to date. The record of expenditures given below is therefore limited to the total annual amounts in the several budgetary items.

It is to be noted that the sum estimated by the Joint Publications Committee as necessary for the editorial conduct of *Biological Abstracts* on the basis of an annual literature of 40,000 titles abstracted without honorarium was \$75,000; the maximum sum available under the grant was \$50,000 annually. That the latter sum would prove inadequate under even extremely economical procedure was clearly foreseen, as the committee's estimate was based on a knowledge of costs in a number of current abstracting services. However, it was decided to go as far as the resources permitted, hoping that some adjustment could be effected. Active operation was begun in 1926, and in December of that year the first number of *Biological Abstracts* was issued.

The project has been organized primarily as a scientific one and on an essentially cosmopolitan basis. Though under American management, the journal is non-provincial in production. In the main the cooperation is from individuals, representing every country with research biological activity; in some cases more formal arrangements have been made. To date over 100,000 abstracts have been published. A fair operating experience has thus been accumulated and in this light it is proposed to review the estimates and conclusions of the Joint Publications Committee in 1923.

EXPENDITURES 1925–30, EXCLUSIVE OF PRINTING AND BUSINESS MANAGEMENT

Year	Salaries	Supplies	Equipment	Travel	Total
1925					$ 19,761.97*
1926	$ 34,957.55	$2,947.63	$ 3,518.70	$ 352.05	41,775.93
1927	45,196.29	3,469.41	875.55	512.74	50,053.99
1928	52,405.12	4,474.32	1,138.17	347.27	58,364.88
1929	67,153.59	3,579.05	720.42	328.34	71,781.40
1930	70,991.38	3,766.81	836.48	879.77	76,474.44
Totals	$270,703.93	$18,237.22	$ 7,089.32	$ 2,420.17	$318,212.61

* Of this sum, $10,000 was allocated to *Abstracts of Bacteriology* and *Botanical Abstracts* to complete editorial work to January 1, 1926, both journals having voted to merge into *Biological Abstracts*; the remainder was used for preliminary organization of *Biological Abstracts*.

(a) *Size of the literature:* While a final and highly authoritative statement can not yet be made on account of uncertainty regarding the literature in certain countries and existence of a known group of serials not yet covered, biological literature as circumscribed in *Biological Abstracts* will total about 55,000 titles in 1931; the committee's estimate on the basis of the 1921 literature was 40,000. The difference is due primarily to three causes; (1) Marked increase in published research since 1921; the encouragement given to biological research in recent years by increased provision of fellowships, etc., is an important factor here. (2) The increasing tendency to publish brief preliminary and progress papers; here should be mentioned also the marked post-war increase in national and international congresses, the proceedings of which add in some years several thousand titles. (3) Underestimates by the committee due to inadequate knowledge of the literature in certain fields.

(b) *Size of a comprehensive abstracting journal for biology:* Adjusting the committee's estimates to the typography and format adopted for *Biological Abstracts*, a page would accommodate twelve abstracts; the average to date is 10.6. It is safe to restate the committee's estimate that the journal for years to come will not occupy more than six inches of shelf room per year. The space economy is the result of a careful study of papers, typography and format.

(c) *Cost of printing:* Actual costs are slightly under the estimates of the committee.

(d) *Subscribers:* The committee estimated that 1,000 institutional subscribers at $15.00 annually could be secured. The number at present exceeds this expectation by several hundred. The committee made no estimate of the number of individual subscriptions that might be secured on a voluntary basis. Little effort has been made to secure subscriptions among individuals pending the more complete development of the journal and the appearance of the indexes. However, about 1,300 are in hand and sustained efforts to increase this number are about to begin.

(e) *Editorial costs:* The editors planned and are operating the organization with the following major items of economy:

(1) *Cooperation from libraries:* To subscribe to, or to exchange for, the approximately 6,000 serials which require perusal for *Biological Abstracts* would, conservatively, cost $30,000 annually. Through courtesies and cooperation generously extended by certain great libraries, notably those of the Academy of Natural Sciences of Philadelphia, the College of Physicians of Philadelphia, and the U. S. Department of Agriculture, this prohibitive expense has been avoided.

(2) *Editorial offices:* The fireproof offices generously furnished by the University of Pennsylvania effect a substantial saving.

(3) *Abstracts on a non-honorarium basis:* Through the splendid cooperation of biologists throughout the world this procedure has conserved $10,000 annually.

(4) *Equipment:* The equipment of the central office is of the simplest kind, hardly sufficient to meet necessities.

(5) *Translating assistance:* In assembling the central staff, both scientific and clerical, attention has been given to linguistic equipment, with the result that writing, reading and speaking knowledge of German, French, Spanish, Portuguese, Italian, Danish, Norwegian, Swedish, Russian, Latvian, Polish and Czech is available without extra cost.

(6) *Section editors:* These editors, recognized specialists who perform the important function of editorial supervision of the manuscript in their respective sections, receive no compensation beyond a complimentary subscription and such books and separates as accompany the manuscript.

Though the saving thus effected exceeds $50,000 annually, the funds available were not sufficient and publication fell seriously into arrears. Experience indicated clearly that the original estimate of $75,000

was accurate. Meanwhile the literature was exceeding 40,000 titles, necessitating an adjustment in editorial funds, though not a pro-rata one. The Rockefeller Foundation accordingly granted permission to use a larger amount annually from the original commitment, beginning in 1929. This, together with the continuing grant of $128,000 in December, 1930, has made available for the four years, 1929, 1930, 1931 and 1932, an average annual sum of about $77,000.

The increased funds made possible augmentation of the scientific and clerical staff, and the work is going forward at more satisfactory speed. For a time large irregular issues were published to reduce arrears, but since January, 1930, the regular monthly publication schedule has been maintained. Also, it has been possible to work intensively on the indexes, the first one having been issued last December.

Something more should be said concerning the indexes. Current issues of abstracting journals largely serve to direct attention to current developments and progress. But more important in the long run is the use of abstracting journals in reference and orientation work. Any one who has tried to use an abstracting journal without indexes or with indifferent ones will agree that its permanent value depends upon the quality of its indexes. Therefore the editors have attempted to set a fairly high standard from the beginning. Though the indexes, too, are a matter of development, it is hoped that the first one holds out a definite promise that something approaching a precision instrument can be constructed. To construct such indexes is a scientific, not a clerical, task; the ideal will be approached in the measure that competently trained scientific personnel is available and the work carried on with the maximum understanding of the needs of investigators.

Estimated editorial costs for the next decade: Over a year ago the executive committee of the board of trustees of *Biological Abstracts* completed a study of the needs for the next decade, with the conclusion that $110,000 annually will be required to carry on the work properly, allocated as follows:

(a) Cost of handling 40,000 papers and books annually, exclusive of honoraria	$ 75,000
(b) Cost of handling the approximately 15,000 papers and books annually by which the literature will exceed the 1923 estimate of 40,000 made on the basis of the 1921 literature	10,000
(c) Abstracting honoraria	15,000
(d) Provision for growth	10,000
	$110,000

As already stated, the original estimate of $75,000 has proved accurate. As no funds were available for honoraria, there was no alternative to the voluntary procedure. Due to the remarkable cooperation of biologists, the plan has worked well, though in certain fields and languages difficulty is experienced. After careful consideration of the problem and of the experience of other abstracting services, practically all of which pay for abstracting, a modest honorarium seems highly desirable, both in justice to the abstractors and in the interest of promptness and completeness.

As will be apparent, the editorial cost of caring for additional literature is not pro rata; it is calculated that $10,000 will provide for the 15,000 papers and books in excess of the 40,000 estimated in the 1921 literature. Finally, provision must be made for growth. Estimates are hazardous; but the growth in research literature during the past ten years continues unabated, and there seems no reason to doubt its continuance in the next decade.

Viewed as a single sum, the funds required appear large. It is pertinent, therefore, to inquire how this cost compares with the cost of research and its original publication. In other words, how much does it cost to get new information and publish it and how much does it cost, relatively, to make this new information generally available through abstracts and indexes, *i.e.,* to take the final step necessary in view of the present complexity and volume of biological research?

Data now available furnish perspective in this direction. Two studies have been made, one in a university, the other of two institutions devoted wholly to research. These show that the total (editorial and printing) cost of *Biological Abstracts* per research paper is one tenth to one twenty-fifth of one per cent. the cost of the research and its publication. In other words, it costs one dollar to provide an abstract of research which to perform and publish costs from one thousand to twenty-five hundred dollars. The cost of the abstracting journal as compared with the cost of the research is thus essentially negligible; whether the service rendered, especially when complete and prompt, is worth this small expenditure should not be difficult to determine.

It may further facilitate perspective if the financial needs of the abstracting journal are seen in relation to the annual expenditures of some of the departments of biological science in a leading American university: Anatomy, $98,000; bacteriology, $91,000; biological chemistry, $77,000; botany, $53,000; neurology, $38,000; pathology, $96,000; pharmacology, $28,000; physiology, $57,000; zoology, $123,000.

It may be wondered why the needs of an abstracting journal are so much larger than those of research journals. It is impossible to compare editorial costs

in abstracting and research journals. The former can not escape heavy costs in this direction; in the latter, the editorial work is of such kind and proportions that, in America at least, it is usually handled without expense to the journals by voluntary services from individuals and their institutions. In short, the present financial problem of research journals is almost wholly one of paying manufacturing costs. In abstracting journals the major cost will always be the editorial, except in those rare cases in which the size of the edition reaches a point where the sheer volume of paper, presswork and binding involved makes the manufacturing costs the higher.

The reasons are obvious. The research journal usually has manuscripts thrust upon it in larger volume than desired. But the largest and most costly problem of the abstracting journal is precisely that of getting its material and attending to the enormous volume of exacting detailed work necessary to make the final product an adequate orienting mechanism with permanent reference value.

Biological Abstracts has been fortunate in having the benefit of the experience of *Chemical Abstracts*, which for over two decades has served chemical science with such conspicuous success. It is a pleasure to acknowledge the many courtesies and important help extended both by the editors and by the officers of the American Chemical Society. *Chemical Abstracts* is a notable achievement, not only because it has become an indispensable tool for chemists but also because, until recently, its cost was met wholly out of income of the American Chemical Society; not until 1929 did some outside subsidy become available to help maintain the journal on its high level of splendid service. It is therefore not surprising that biologists should inquire to what extent *Biological Abstracts* might become similarly self-supporting. This question deserves careful analysis. The following facts are pertinent.

The non-overlapping professional membership (about 9,000) of the nearly thirty North American societies concerned primarily with research biology is about one half the membership of the American Chemical Society (over 18,000). On the other hand, the research literature in biology is larger than in chemistry and is scattered in three times as many serials. Put in another way, biological literature is larger, more diversified and more widely scattered, and there are only half as many individuals to bear the cost of the abstracting journal.

The explanation lies in large part in the extensive penetration of chemistry into industry, which claims more than half the membership of the American Chemical Society. In biology the two great fields of application are agriculture and medicine; unlike the chemist in industry, however, the agricultural worker and the clinician are seldom members of the basic science societies and are therefore not supporters of an abstracting journal in biology.

The intimate application of chemistry in industry is reflected also in the substantial income from advertising built up in the journals of the American Chemical Society, aggregating $110,000 net in 1930 and constituting an important factor in maintaining the large coordinated publication program of the American Chemical Society, including *Chemical Abstracts*. So far the income from advertising in *Biological Abstracts* is but a few per cent. of this amount and is certain to remain a small fraction for years to come.

Such differences have an important relation to the conduct of scientific enterprises in biology. They bear out the conviction of the committee in planning *Biological Abstracts* that such a journal can not be self-supporting to the extent of providing for the enormous amount of abstracting, editorial, indexing and bibliographic work involved if the journal is to be published at a price within reach not only of larger institutions but of smaller ones and individuals as well. Without this general availability such a journal can not approximate its full usefulness.

Biological Abstracts is in the midst of its development. Its present shortcomings are obvious, especially the delays in publication of abstracts and indexes, though these are being reduced. However, the project has advanced far enough reasonably to demonstrate the correctness of the Union's original conclusion, namely, that a single inclusive abstracting journal for biology is not only possible but practical and economical as well, and sound on general principles. Its development can proceed as rapidly as editorial and subscription funds enable the editors to deal adequately and expeditiously with the editorial and publication problems involved.

The problems in biology are difficult, in fact, bafflingly elusive and complicated in many directions. Highly circumscribed and specialized attacks are increasingly necessary to penetrate a little further. In this circumstance it is inevitable that even restricted outlooks involve extensive synthesis of specialized data gathered from various fields. The more minute the analysis, the more extensive the synthesis needed to gain perspective and comprehension in the coordinated phenomena and processes of organisms. Analysis and synthesis therefore go hand in hand, the one providing the raw material, the other constructing the edifice. It is to facilitate both that the Union has undertaken to perfect a comprehensive abstracting journal in biological science.

THE UNION AND BIOLOGICAL ABSTRACTS

By Professor C. E. McCLUNG
PRESIDENT 1923–30

Biological Abstracts is the spontaneous outgrowth of a need, deeply felt by many groups of biologists, brought to fruition through an unusual degree of unanimity of opinion in a large and highly diversified series of separate societies. Organizations roughly represent current interests and opinions in any given field. The subjectivity and individuality of the biological mind finds expression in the score or more of national societies which give homes to those who, for a moment, find common intellectual companionship possible. A wide interest in biology necessitates, for the individual investigator, membership in as many as a dozen societies if he desires helpful associations. This tendency towards division and dispersion shows in the new biological societies still being formed in apparent opposition to the gradual breakdown of arbitrary divisions between parts of a subject, showing a natural unity. Such a scattering of forces makes a concerted effort in the interest of all biologists difficult or impossible. A realization of this organic weakness was doubtless the motive which led the secretary of the American Naturalists to call a conference of the secretaries of the various biological societies meeting in Chicago in 1921. The result of this conference was a request to the Division of Biology and Agriculture of the National Research Council to use its good offices in promoting some sort of common organization for all American biologists. Under the chairmanships of Dr. L. R. Jones and Dr. F. R. Lillie this eventuated in the Union of American Biological Societies.

At a meeting of the council of this new Union it was unanimously decided that the greatest present need in biology is a system of abstracts similar to that which has so well served chemical investigators for a quarter century. Over a period of several years a committee on publication and bibliography of the Division of Biology and Agriculture had been studying problems in this field; and the botanists, under the leadership of B. E. Livingston, chairman of this committee, had established *Botanical Abstracts*. The bacteriologists likewise undertook the publication of *Abstracts of Bacteriology* before the Union was established. The inherent weaknesses in partial services of this character had made themselves alarmingly apparent and the continued existence of these budding enterprises was seriously threatened. To bring together all the available experience in this new form of publication service there was established the Joint Publication Committee with equal numbers of representatives from the Division of Biology and Agriculture and from the Union. Later, representation of the A. A. A. S. was provided for. By this Joint Publication Committee a careful detailed study of the amount, character and distribution of current biological literature was made, existing bibliographic services were studied and compared, and finally complete plans for a comprehensive abstracting service in biology were drawn up. These were presented before various gatherings of biologists and published in SCIENCE, November 28, 1924.

At every step, representatives of the different societies were consulted to determine the character, scope and form of service that would best serve the workers in each particular field, the aim being not to construct a logical system but rather one of practical, workable character. This policy has been followed from the beginning, but since each individual has his own peculiar requirements, a journal serving thousands must follow a policy of compromise, seeking that which will serve the largest number. Finally, to be assured that each individual was as nearly satisfied as might be with the plans his representatives had formulated, a referendum vote was taken, and a surprising degree of unanimity disclosed in favor of proceeding to the practical execution of the project. Convinced of the worthiness of the undertaking and the strong opinion back of it, the National Research Council undertook to assist in finding financial support for it.

Experience in the administration of *Botanical Abstracts* and *Abstracts of Bacteriology* had persuaded those who were in charge that only a salaried editorial staff would be able to handle so ambitious an undertaking. At the same time it was believed that a price low enough to permit the individual worker to have his own copy of the journal would be necessary in order to secure maximum effectiveness in its use. The response to the questionnaire led to the belief that enough money would be derived from subscriptions to pay the costs of printing and distribution and so the request finally presented to the Rockefeller Foundation was for only the amount necessary to support the central editorial staff and its work. The soundness of the estimate was later demonstrated in the practical operation of the plans. Only an unexpected and entirely disproportionate increase in the bulk of biological literature following the war has served to modify the estimated cost of operating the system.

From the beginning it had been the judgment of all those intimately connected with the development of *Biological Abstracts* that the ultimate success of the project requires an international cooperation as general as can be secured amid the diversity of languages represented in the literature. Accordingly,

after plans had been drawn and approved as indicated, and tentative support secured, biological organizations and individuals in Europe were visited and the plans presented for suggestions and advice. Although the *Concilium Bibliographicum* and the *Zoological Record* occupy different fields from that proposed for *Biological Abstracts*, those in charge were consulted, and cooperation suggested. Always the effort was made not only to avoid injury to any existing service, but ways to make the anticipated facilities of *Biological Abstracts* actively helpful were sought.

Finally, after all the years of planning, and of innumerable discussions, the request for financial support, presented by the National Research Council, was granted by the Rockefeller Foundation, and *Biological Abstracts* was ready for launching. No one unfamiliar with the practical operation of such enterprises can imagine the difficulties and complexities involved in their organization and operation.

First, it was necessary to build up an operating staff out of almost untrained material. One invaluable person, without whom *Biological Abstracts* would have been inconceivable, had been available for the days of planning, and he was now called upon to take charge when plans were to be executed. Dr. J. R. Schramm, editor-in-chief of *Biological Abstracts*, put aside his scholastic career, and, starting from nothing, sought out promising material and began training an editorial and clerical staff which is now, and always has been, characterized by a high degree of efficiency and devotion. Printers were consulted about typography, experts in papers advised regarding details of their weight, opacity and durability, psychologists gave their judgment concerning the most readable size and arrangement of type, biological groups formulated workable taxonomic systems, and in these and many other ways the practical conduct of the journal was determined.

A periodical of the scope and character of *Biological Abstracts* can, at best, be only an approximation to the ideal of completeness and selectivity. No one so fully realizes what remains to be done to approach this ideal as do the members of the editorial staff, who have formulated the plans for achieving the objective established by the representatives of our biological societies. But even in its present form it has served as a model for *Social Science Abstracts* and finds encouragement for the future in the words of the London *Lancet:*

> If this is the state of affairs within the field of medicine, how hopeless it may seem to bring medicine into any sort of effective contact with the whole scattered field of biology. But courage can achieve most things, and a first step has been made by the promoters of *Biological Abstracts*, who in 1927 began a monthly publication with no smaller object than to summarize the whole of current publications in biology, to abstract the relevant parts of some 6,000 journals and to make the results available to everybody. Judging from their first two years, they have made a good start at what seemed at first an impossible task, and, aided by a grant from the Rockefeller Foundation, they have issued a periodical which no one can read, but which almost everyone can consult with profit. Biology as a whole is gathered up together, and so it is very much easier for outsiders to find out what is going on. Revelations come as often as not from browsing about a little outside one's own proper field. It has as yet to find its permanent field in conventional biology, though it has done enough to show that it deserves all encouragement and support.

By the aid of the Rockefeller Foundation and the helpful cooperation of over 3,000 collaborators and section editors, plus the self-sacrificing devotion of a group of biologists who have laid aside their own work and teaching for the drudgery of editorial service, every biologist may have as his own a key which will unlock the published records of biological research the world over for the small sum which he might pay for a hat or a pair of shoes. The response in subscriptions so far has been splendid, the journal having already the largest number of subscribers of any technical biological publication; but to reach the fulness and completeness of *Chemical Abstracts*, somewhat the same unified support which it commands will be required. Those who have been charged by their fellow workers with the heavy responsibility of bringing to fruition their hopes for a prompt, accurate and full report upon current biological literature believe that it is necessary only to let it be known that now full support from individual workers must be forthcoming in order to secure the subscriptions that were provisionally promised in the referendum. In a very real sense it may be said that the future of *Biological Abstracts* is now in the hands of those whom it serves.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PRELIMINARY ANNOUNCEMENT OF THE PASADENA MEETING

By Dr. CHARLES F. ROOS, Permanent Secretary

ABOUT twenty-five scientific societies, together with the fifteen sections of the American Association for the Advancement of Science, will hold scientific sessions at Pasadena from June 15 to 20. This will be

the eighty-eighth meeting of the association and the first of a new series of annual summer meetings. The Los Angeles Chamber of Commerce has very generously furnished the funds necessary for mailing a printed preliminary announcement to all members of the association. Additional copies will be supplied by Mr. Harry H. Main, of the chamber, to those who request them. The mailing of this announcement makes it seem unwise to do more than emphasize important events and give additional information here.

As mentioned in the mailed announcement, much of the cost of the meeting is to be raised locally. Thus, the Los Angeles Chamber of Commerce expects to spend $5,000 or more in printing and mailing the preliminary announcement, in printing the general program, in providing badges, signs, busses, excursions, lanterns and pay of operators, and in furnishing clerical assistance of all kinds. The California Institute of Technology will spend $800 in securing invited speakers. The Mount Wilson Observatory will spend $500, and the City of Pasadena $350 for incidental local expenses of the local committee, and the Huntington Library and Art Gallery will spend $1,000 or more on what promises to be one of the most brilliant receptions ever planned for the association. This reception will be held on the estate of the Huntington Library and Art Gallery, San Marino, California, at 2: 00 p. m. on Monday, June 15.

The association has appropriated $2,500 to pay expenses of invited speakers and expects to spend an additional $3,000 to $4,000 on this meeting, in addition to funds of about $7,000 obtained from the Los Angeles Chamber of Commerce and the host institutions.

It is hoped that associate-membership fees and registration fees obtained in connection with the meeting will be sufficient to make it unnecessary for the association to use any of its reserve or current membership funds. Members who register will be entitled to an unusual number of special privileges, and therefore all who plan to attend should go immediately to Throop Hall to register. The registration fee will be two dollars, but life members and members of the association in good standing may register for one dollar. Associates for the meeting may register without paying any registration fee if they show their associate cards. Only those who register will receive badges and the official identification cards.

Official identification cards and badges will admit to the reception garden party at the Huntington Library and Art Gallery, to reserved seats for the five popular evening lectures at the Greek Theatre in Griffith Park, and to all the excursions arranged by the association, and will entitle the holders to free transportation at times between the hotels, meeting places, and the Greek Theatre in Griffith Park, as well as to many other courtesies.

Nearly all scientific sessions will be held at the California Institute of Technology. The astronomers, however, plan one or more sessions on Mount Wilson and the botanists plan one or more sessions at near-by botanical gardens.

All who will present papers before the American Association for the Advancement of Science and the associated societies should without delay send two copies of their manuscript and an abstract of 1,000 words to Austin H. Clark, director of the Press Service, American Association for the Advancement of Science, Smithsonian Institution Building, Washington, D. C. Each manuscript should bear, at the top of the first page, the name of the organization before which the paper is to be presented, with information as to the date of presentation as nearly as that may be stated.

The Pasadena meeting will be held under the presidency of Dr. Franz Boas, of Columbia University. Dr. Boas is known throughout the world for his contributions to anthropology and has been the teacher of most American anthropologists. On Monday evening he will deliver an address on "Race and Progress," at which time the retiring president, Dr. Thomas H. Morgan, of the California Institute of Technology, will preside. On Tuesday, June 16, Dr. H. D. Arnold, director of research, Bell Telephone Laboratories, New York City, will give an experimental lecture entitled "Science Listens." On Wednesday evening, June 17, Dr. Arthur Day, director of the Geophysical Laboratory of the Carnegie Institution of Washington, will speak on "The Present Status of Seismology." On Thursday evening, June 18, Dr. Charles A. Beard, historian, author of "The Rise of American Civilization," "American Party Battles," etc., will speak on "Scientists and History." On Friday evening, June 19, a symposium conducted by an historian, an economist and a scientist, on "The Impact of Science upon Civilization, Past, Present and Future," is planned.

In honor of President Boas a special symposium on "The Antiquity of Man" will be held. The speakers for this occasion and the titles of their addresses are as follows: Barnum Brown, American Museum, "The Folsom Culture"; Alfred Romer, University of Chicago, "Pleistocene Mammals and their Relation to Early Man in America"; M. R. Harrington, Southwest Museum, "The Meaning of Gypsum Cave"; Malcolm J. Rogers, San Diego Museum, "Fossil Human Bones found near San Diego, California"; David Banks Rogers, Santa Barbara Museum, "Traces of Early Man near Santa Barbara, California"; and Chester Stock, California Institute of Technology, "Review of Antiquity of Man in the Southwest."

The president of the Pacific Division of the American Association for the Advancement of Science, Dr. T. Wayland Vaughan, will conduct a symposium on "Oceanographic Problems." Papers will be given by T. Wayland Vaughan, P. S. Galtsoff, T. G. Thomson, C. B. Van Wiel and others.

A special session of the zoologists and biologists in honor of a former president of the association, Dr. David Starr Jordan, scientist, teacher and administrator, who has just celebrated his eightieth birthday, is planned.

A number of special symposia are being planned by the sections in cooperation with the national societies which are meeting with the association.

D. R. Curtiss, O. D. Kellogg and J. V. Uspensky will give invited addresses before Section A (Mathematics). P. W. Bridgman, C. J. Davisson, Alexander Goetz, Fritz Zwicky, W. F. G. Swann, R. H. Fowler (Cambridge, England), W. Pauli (Zurich), W. D. Coolidge, E. O. Lawrence, C. C. Lauritsen and M. A. Tuve will deliver addresses before Section B (Physics) and the American Physical Society. Section C (Chemistry) and the Pacific Intersectional Division of the American Chemical Society are planning symposia on "Photochemistry and Band Spectra," "Chemical Reaction Rates," and "Quantum Mechanics of the Chemical Bond." R. H. Fowler will address Section D (Astronomy) on "The Internal Structure of Stars." The geologists, Section E, are planning symposia on "Rock Cut Surfaces," "Coast Range Structure," "Earthquake Proof Structures" and "Seismological Problems." Section F (Zoological Sciences) plans special symposia on "Economic Entomology with special reference to Termites and Citrus Enemies" and "Problems in Genetics." Section G (Botanical Sciences) plans several excursions and field trips to some of the many botanical gardens near Pasadena. The special symposium of Section H (Anthropology) on "The Antiquity of Man" has already been described in this note. The Pacific Division of the Social Science Research Council, which will meet with Section K (Social and Economic Sciences), plans a large number of round-table discussions. Section L (Historical and Philological Sciences) will join in the special program in honor of Dr. David Starr Jordan. The Engineers, Section M, are planning a symposium on "The Colorado River Dam and Aqueduct." Section N (Medical Sciences) will hold a symposium on "High Voltage X-Ray Tubes and their Medical and Biological Possibilities."

In addition to these special sessions and symposia the associated societies and some of the sections are holding sessions for miscellaneous scientific papers.

An unusual number of interesting scientific exhibits have already been secured.

Special low rates quoted by the Pasadena hotels for the meeting of the association are given below.

HOTELS

CONSTANCE—940 E. Colorado St. All rooms with bath. Single rooms, \$2.50 to \$5.00 per day; double rooms, \$4.00 to \$6.00 per day.

CROWN—677 E. Colorado St. Single rooms (with bath), \$2.00 to \$3.00; double rooms, \$3.50 to \$4.50. Suites, \$5.00 to \$6.00.

EL REY—87 E. Green St. Single, \$1.00 to \$1.50; (shower), \$1.50; (with bath), \$2.00 to \$2.50; double room, \$1.50 to \$2.00; (shower), \$2.00; (with bath), \$2.50 to \$3.00.

GRANT—127 N. El Molino Ave. All rooms have private bath; single rooms, \$2.00 per day; double, \$2.50.

GREEN—Corner Raymond Ave. and Green St. Single room, \$2.00 to \$2.50; (with bath), \$2.50 to \$4.00; double rooms, \$3.00 to \$3.50; (with bath), \$3.50 to \$5.00.

HUNTINGTON—South Oak Knoll Ave. Single rooms (with bath), \$4.00 per day; double rooms (with bath), \$7.00 per day.

HOLLY—4 Holly St. Single room, \$1.50; (with bath), \$2.50; double room, \$2.00; (with bath), \$2.50.

LIVINGSTONE (Apartment Hotel)—139 South Los Robles Ave. All rooms with bath; single rooms, \$3.50; double rooms, \$5.00.

MARYLAND—389 E. Colorado St. Single rooms (with bath), \$4.00 per day; (without bath), \$3.00; double rooms (with bath), \$6.00; (without bath), \$5.00 per day.

PARK VIEW—Corner Raymond and Green Sts. Single room, \$1.50 to \$2.00; (with bath), \$2.00 to \$2.50; double rooms, \$2.00 to \$2.50; (with bath), \$3.00 to \$3.50.

SOUTHERN—125 South Fair Oaks Ave. Single room, \$1.00; double room. \$1.50.

SIMPKINSON—141 North Madison Ave. \$1.50 and up.

TAYLOR—64 West Colorado St. Single room, \$1.00 and \$1.50; (with bath), \$2.00 and \$2.50.

VISTA DEL ARROYO—125 South Grand Ave. Single room (with bath), \$5.00 per day; two single rooms, with bath between, \$4.50 per day, each; double room (with bath), \$8.00 per day.

AUTO CAMP

CLARK'S AUTO CAMP—3019 E. Colorado St. All modern conveniences may be obtained for \$1.50 per day.

The Hotel Constance, which is nearest to the California Institute of Technology, is reserving a number of rooms for members of the Botanical Society of America. Members of this society should write directly to this hotel for reservations, stating that they are members of the Botanical Society.

Information concerning low summer excursion rates are given in the mailed announcement and can be obtained from any railroad agent. The usual certificate plan for the winter meetings will not be in effect, since excursion rates are lower (\$140 round trip from New York City).

SCIENTIFIC EVENTS

GEOLOGICAL SURVEYS IN ALASKA

THE Interior Department announces that plans for the field projects to be undertaken in Alaska by the Geological Survey this season have now reached an advanced stage and the several parties will start for the field during this month.

By far the most intensive work that will be done by the Geological Survey in Alaska this season will be that financed by the special appropriation for research along the Alaska Railroad and directed toward the examination of mineral deposits contiguous to the railroad that may contribute to its revenues by furnishing tonnage. Nine separate parties will be assigned to this work. Most of them will be stationed in mining camps from one end of the railroad to the other—Fairbanks, Kantishna, Copper Mountain, Valdez Creek-Chulitna, Willow Creek, Anthracite Ridge, Girdwood and Moose Pass—but one party will carry on certain general studies throughout the tract near the railroad. Direct supervision of all these projects has been assigned to S. R. Capps, whose long service in the Geological Survey's Alaska work and whose personal familiarity with most of the mining camps near the railroad make him especially fitted to conduct and direct the work.

Geologists will be assigned to all these projects, but the personnel of different parties will vary greatly, as it will be determined by the individual requirements of the specific job. Thus, in the Kantishna, Copper Mountain, Anthracite Ridge and Girdwood areas, where adequate maps for platting the geologic information are not available, the parties will be accompanied by topographic engineers and other personnel needed to make the essential maps. In certain projects, as at Anthracite Ridge, considerable test pitting and other manual work will be required, which will call for the services of a number of laborers. Some of the parties will maintain their own camps, and others will be able to obtain accommodations for much of the time at the mines or in the settlements. Thus the work near Fairbanks will be conducted mainly from that town as a base, whereas the parties in the Kantishna, Copper Mountain, Valdez Creek-Chulitna and Anthracite Ridge districts will maintain camps supplied by pack trains. Although each region presents different problems, the work in each will have the common aim of supplying as much information as possible in answer to the question "What quantity of mineral products appears to be available that might swell the railroad's business?"

The Alaska projects that will be financed by funds appropriated directly for Geological Survey investigations as distinguished from those carried on for the Alaska Railroad are eight in number and are distributed geographically as follows: Topographic mapping near Wrangell, in southeastern Alaska; mining investigations in southeastern Alaska; general investigations in the vicinity of Glacier Bay; topographic mapping in the Klutina Lake region of the Copper River Basin; geologic investigations in the headwater portions of the Copper River Valley; general studies in the western part of the tract between the Yukon and Tanana Rivers; geologic and topographic exploration and reconnaissance survey of the Tikchik Lake region north of Bristol Bay, and general field studies of mineral resources.

The chief Alaskan geologist, Philip S. Smith, will spend as much of the open season as practicable in the field in Alaska, with the object of obtaining information about recent mining developments throughout the territory, for the purpose of preparing the Geological Survey's annual report on the mineral industry of Alaska for the current year. He will visit such of the above-mentioned parties as can be readily reached and will examine the larger producing mining camps and such of the smaller ones as have not been recently visited by Geological Survey parties, so far as time and other conditions permit.

ECONOMIC CONFERENCE FOR ENGINEERS OF THE STEVENS INSTITUTE OF TECHNOLOGY

AN economic conference for engineers will be held this summer, from August 30 through Labor Day, September 7, at the engineering camp of Stevens Institute of Technology in northern New Jersey. President Harvey N. Davis, in issuing the preliminary outline of the program for the conference, announced that the engineering alumni of Columbia University and the alumni of Stevens, under whose joint auspices the conference will be held, will welcome to the camp graduates of other colleges and junior members of the national engineering societies. The hours for lectures, conferences and round-table discussions by some of the leading economists and engineers of the country are to be scheduled so as to permit the men in camp to make full use of its unusually good facilities for land and water sports. The serious part of each day's program will have two main elements: in the morning the lectures and discussions will deal with "The Dollar Factor in Engineering," or "Technique in Calculations Involving Money"; at the open forum and round table discussions in the evening, elements in depression, seasonal and cyclical fluctuations will be considered.

The Carnegie Corporation, on the recommendation of the American Association for Adult Education, has endorsed the project through a grant of $1,500. A joint conference committee of Columbia and Stevens graduates has been formed on which Columbia is represented by Professor James K. Finch, of the Columbia University faculty; Mr. Lindsay H. Welling, of A. Iselin & Company, and Mr. Edward C. Meagher, of the Texas Gulf Sulphur Company; and Stevens is represented by Mr. Robert C. Post, of Post & McCord; Mr. Walter Kidde, of the Walter Kidde Construction Company, and Mr. Thomas W. Kirkman, of the Kirkman Engineering Corporation.

The camp where the Economic Conference is to be held is the Engineering Camp of Stevens Institute of Technology, near Johnsonburg, Warren County, New Jersey. It is a 370-acre tract, varied in topography within which is a 30-acre lake. The lake with two 90 ft. piers affords excellent opportunity for swimming and water sports. There are two athletic fields offering opportunity for soccer, volley ball, baseball, basket-ball, lacrosse and other sports. The camp buildings, constructed last summer when the camp was opened for freshman surveying work, include sixteen residence cabins scattered through the woods, an administration building, and a mess hall which accommodates 170 men. All camp buildings are built along modern lines with regard to the problems of sanitation and comfort and are electrically lighted. The camp water is supplied by an artesian well 218 feet deep.

THE ECOLOGICAL SOCIETY OF AMERICA

THE Ecological Society of America will hold a summer meeting this year, participating in the first national meeting of the American Association for the Advancement of Science to be held on the Pacific coast.

The meeting will be at the California Institute of Technology, Pasadena, California, from June 15 to 20, inclusive. The sessions of the Ecological Society of America will be held on the mornings of Wednesday and Thursday, June 17 and 18. The afternoons of the meeting are to be devoted mainly to informal discussions and field excursions. Several field trips under the leadership of specialists have been planned to afford opportunities for seeing something of the plant and animal communities of especial interest, and also for the inspection of various ecological installations for experimental investigations.

There will be a dinner for ecologists at the Hotel Constance in Pasadena on Friday evening, June 19, preceding the lecture at the Greek Theater in Griffith Park, Los Angeles, the same evening.

Those intending to present papers at the sessions of the Ecological Society of America should send in the title, author's name, time for delivery, institution represented, facilities required, and a short abstract (not more than 200 words), to the secretary of the society for the Pasadena meeting, Dr. H. de Forest, 3551 University Avenue, Los Angeles, before May 20.

At one of the two sessions of the society there is to be a general, informal discussion of ecological problems of the Pacific coast region.

THE CENTENARY MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE preliminary program of the centenary meeting of the British Association for the Advancement of Science, which will be held in London from September 23 to 30, has now been issued.

On Wednesday, September 23, in the Albert Hall (Faraday Centenary Exhibition) at 3:00 P. M., the Right Honorable J. C. Smuts will assume the presidency of the association in succession to Professor F. O. Bower, and will receive the invited delegates of societies and institutions, and of universities, colleges and cities in which the association has held meetings in the past.

On the same day, in the Central Hall, Westminster, at 9:00 P. M., the presidential address will be delivered by General Smuts. The address will be relayed to other halls if necessary. Admission will be by special ticket, for which members will be given the opportunity to apply in advance.

Evening discourses to the members will be given by the following lecturers: Thursday, September 24. Professor W. A. Bone, F.R.S. (on The Photographic Analysis of Explosion Flames); Sir P. Chalmers Mitchell, F.R.S. Saturday, September 26. Sir Arthur Keith, F.R.S.; Sir Oliver Lodge, F.R.S. (A Retrospect of Wireless Communication). Tuesday, September 29. Sir William Hardy, F.R.S.; Sir James Jeans, F.R.S. On Tuesday evening, September 29, the Huxley memorial lecture of the Royal Anthropological Institute will be given by Dr. G. Thilenius, and through the kind cooperation of the institute will be open to members of the association.

Sectional meetings will begin on Thursday morning, September 24, and will be continued daily, at the following places: Imperial College of Science and Technology, the Imperial Institute, the Natural History Museum, the Victoria and Albert Museum, the Royal College of Music, the Royal Geographical Society, and the Entomological Society.

The sectional transactions will include the following presidential addresses: Section A (Mathematical and Physical Science), Sir J. J. Thomson on "The Growth in Opportunities for Education and Research in Physics in the past Fifty Years." Section B (Chemistry), Brigadier-General Sir Harold Hartley

on "Michael Faraday and the Theory of Electrolytic Conduction." Section C (Geology), Professor J. W. Gregory. Section D (Zoology), Professor E. B. Poulton, F.R.S., on "A Hundred Years of Evolution." Section E (Geography), Sir Halford J. Mackinder on "The Human Habitat." Section F (Economic Science and Statistics), Professor E. Cannan on "Internationalism in Economic Theory." Section G (Engineering), Sir Alfred Ewing on "Power" (including the thesis proposed by Sir Frederick Bramwell in 1903 to deal with "the whole question of the prime movers of 1931, and especially with the then relation between steam engines and internal combustion engines"). Section H (Anthropology), Professor A. R. Radcliffe-Brown. Section I (Physiology), Dr. H. H. Dale on "The Biological Nature of Filtrable Viruses." Section J (Psychology), Dr. C. S. Myers on "The Nature of Mind." Section K (Botany), Professor T. G. Hill on "The Advancement of Botany." Section L (Educational Science), Sir Charles Grant Robertson on "Educational Theory, 1831 and 1931." Section M (Agriculture), Sir John Russell on "The Changing Outlook in Agriculture."

Excursions and visits, both general and sectional, will be arranged to many points of scientific interest in and near London. An invited party will visit York, the birthplace of the association, on Saturday and Sunday, September 26–27. Down House, the home of Darwin, now held by the association in custody for the nation, will be open to members throughout the meeting, as well as for sectional visits to be arranged. A geological excursion to East Anglia is contemplated during the week preceding the meeting, September 16–22.

It is anticipated that receptions will be given on Thursday, September 24, by the Royal Society in connection with the Faraday Centenary Celebration, and on Friday, September 25, by H.M. Government. Other receptions are expected to be arranged.

SCIENTIFIC NOTES AND NEWS

DR. ALBERT A. MICHELSON, the eminent physicist, died at Pasadena on May 9, aged seventy-eight years.

THE National Advisory Council on Radio in Education announces the first of a series of radio lectures, entitled the "Men of America" series, to be broadcast over country-wide networks. President Hoover, speaking from the White House, will introduce the first speaker of the series, Dr. Robert A. Millikan, who will talk from Los Angeles at ten o'clock daylight saving, New York time, on the evening of Friday, May 22. Dr. Millikan's inaugural address will be transmitted to the first annual assembly of the council in session in New York at the New School for Social Research.

THE Institute of Human Relations was dedicated on May 9 at Yale University. Dr. Ray Lyman Wilbur, Secretary of the Interior, spoke on "The Institute and American Education"; Dr. George E. Vincent, formerly president of the Rockefeller Foundation, on "The Institute and the Broader Aspects of Public Health"; Governor Wilbur L. Cross, of Connecticut, on "The Institute and the Community"; and President James Rowland Angell on "The Organization and Work of the Institute."

DR. WILLIAM H. WELCH, professor of the history of medicine and director of the Institute of the History of Medicine at the Johns Hopkins University School of Medicine, sailed for Europe on May 2. He will receive a medal to be conferred on him by the Royal Sanitary Institute of London.

A MARBLE bust of Mr. Thomas A. Edison was unveiled on May 7 in Munich at the German Museum Hall of Fame beside that of Werner von Siemens, Germany's electrical pioneer. Mr. Howel Henry Barnes, Jr., of the General Electric Company, unveiled the bust for the Edison Pioneers Society and the American Institute of Electrical Engineers, the donors. He read a letter from Mr. Edison, who expressed the hope that international friendship might be promoted by electrical science.

THE Daniel Guggenheim Gold Medal for notable achievement in aeronautics has been awarded to Dr. Frederick William Lancaster, of Birmingham, England, for his contributions to "the fundamental theory of aerodynamics." Previous awards of the medal have been to Orville Wright and Dr. Ludwig Prandtl.

THE fifth award of the Charles B. Dudley medal, established by the American Society for Testing Materials for recognition of meritorious papers on research in engineering materials, has been made to Mr. A. H. Pfund, professor of physics at the Johns Hopkins University. The award was presented for a paper entitled "Hiding Power Measurements in Theory and Application," presented at the annual meeting of the society in 1930.

COLONEL WILLIAM L. KELLER, Medical Corps, chief of surgical service, Walter Reed General Hospital, Washington, D. C., will be the recipient on June 2 of the honorary degree of doctor of science at the commencement exercises of the Medical College of Virginia. Dr. Keller is an alumnus of this institution.

IT is announced in *Nature* that the Linnean Medal for 1931 of the Linnean Society of London has been awarded to Professor Karl E. von Goebel, professor of botany in the university and director of the Botanical Gardens, Munich. The following have been proposed as foreign members of the society: Professor Carl Christiansen, of Copenhagen; Dr. K. E. Correns, director of the Kaiser Wilhelm Institute of Biology, Berlin; Dr. L. Diels, director of the Botanical Gardens, Berlin, and Professor F. A. F. C. Went, professor of general botany in the University of Utrecht.

STUDENTS, colleagues and friends of Professor Duncan Starr Johnson gathered for dinner at the Belvedere Hotel in Baltimore on May 2 to celebrate the completion by Professor Johnson of thirty years as professor of botany at the Johns Hopkins University. Following the addresses, an oil painting of Professor Johnson, done by Mr. Thomas C. Corner, was presented to President Ames of the university to keep until a formal presentation can be made at a gathering of the university as a whole. There was also presented to Professor Johnson a book of letters and portraits.

ON the evening of May 4 the eighth annual meeting of the Virginia Chapter of Sigma Xi was held. Twenty-one candidates were admitted to membership at this meeting. The annual address was delivered by Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, on "The Philosophic Concept of Modern Physics." The seventh annual award of the President and Visitors' Research Prize of one hundred dollars was made to Dr. S. A. Mitchell, professor of astronomy and director of the Leander McCormick Observatory, for his work on "The Spectrum of the Chromosphere."

THE twenty-second Kelvin lecture of the British Institute of Electrical Engineers was delivered on April 30, by Professor William L. Bragg, on "The Architecture of Solids." On this occasion the Faraday Medal was presented to Mr. Charles H. Merz.

PROFESSOR GEORG TISCHLER, professor of botany at the University of Kiel, has accepted an invitation to occupy the Speyer professorship at the Johns Hopkins University for 1931–32.

DR. ALEXANDER MCADIE, since 1913 A. Lawrence Rotch professor of meteorology at Harvard University and director of the Blue Hill Observatory, will become professor emeritus next February. He will be on sabbatical leave during the first half of the next academic year.

DR. FRED GRIFFEE has succeeded the late Dr. Warner Jackson Morse as director of the Maine Agricultural Experiment Station.

MR. R. E. DOHERTY, consulting engineer of the General Electric Company, has been appointed professor of electrical engineering in the Sheffield Scientific School of Yale University. Professor Scott will continue as chairman of the department during the coming year when he will have reached the retiring age and Professor Doherty will then become the head of the department.

PROFESSOR JAN SCHILT, of Yale University Observatory, has been appointed head of the department of astronomy at Columbia University. He will take up his duties there about October 1.

DR. GEORGE SHERMAN AVERY, member of the staff of the Liggett and Myers Research Foundation at Duke University since 1928, has been appointed professor of botany at Connecticut College.

DR. JOHN A. KOLMER, professor of pathology and bacteriology at the Graduate School of Medicine, University of Pennsylvania, has been appointed professor of immunology and chemotherapy at Temple University School of Medicine on a part-time basis.

DR. N. B. MACLEAN, formerly professor of mathematics at the University of Winnipeg, has been appointed professor of mathematics at McGill University, as successor to Professor D. A. Murray, who has retired.

DR. M. N. STATES has resigned his professorship in physics at the University of Kentucky to accept the directorship of research and development of Central Scientific Company, succeeding Dr. P. E. Klopsteg, who became president of that company a year ago. Dr. States assumes his new duties at the close of the present school year.

DR. GEORGE N. WOLCOTT, identified with the early developments of economic entomology in Porto Rico, later working in Haiti and Peru, has returned to Porto Rico, being at present entomologist at the Isabela Sub-Station, of the local department of agriculture at Isabela.

DR. ROBERT M. OSLUND, acting head of the department of physiology at the University of Illinois College of Medicine, has resigned in order to complete his medical training. He will act as interne in California during the coming year.

MR. PAUL H. OEHSER was appointed editor for the U. S. National Museum on April 16, to succeed Dr. Marcus Benjamin, who has retired. Mr. Oehser for the past six years has been doing editorial work at the Biological Survey, U. S. Department of Agriculture. His office will be on the third floor of the Smithsonian Building.

DR. F. LAMSON-SCRIBNER, of the U. S. Department of Agriculture, who retired in 1922 and who was

eighty years of age on April 19, has been appointed by the Chicago Century of Progress Exposition to cooperate with the department and with the state agricultural experiment stations in planning an exhibit for the experiment stations.

THE Institute of International Education of New York City announces that Mr. Max Askanazy, director of the Pathological Institute of the University of Geneva and founder of the International Society for Geographical Pathology, will lecture this coming fall in the United States and Canada. He has recently lectured in various European centers and will speak on "The Pathology of Bone Marrow and Cancer." Mr. Hans Kleinmann, privatdozent of the Pathological Institute of the University of Berlin, inventor of the micronephelometer and microcolorimeter, will lecture from October 15 to December 15.

SIGMA PI SIGMA, honorary physics fraternity, recently elected Dr. W. E. Forsythe, of the Nela Research Laboratories, as an honorary member of the society. After addressing an open meeting of the Gamma chapter at the Pennsylvania State College on "The Production and Measurement of Ultra-Violet Radiation," Dr. Forsythe was initiated into the fraternity on April 27.

THE annual dinner of the Thomas Say Entomological Society of Purdue University was held April 15, at which time Dr. W. S. Blatchley addressed the society on "The Days of a Naturalist."

DR. FREDERICK P. GAY, of the College of Physicians and Surgeons of Columbia University, will deliver the eighth Harvey Society Lecture at the New York Academy of Medicine, on Thursday, May 21. His subject will be "Tissue Resistance and Immunity."

AT the invitation of the committee on the revision of the United States Pharmacopoeia to recommend standards for vitamins A and D to be incorporated in the next decennial issue of the volume, to be published in 1935, a number of students of vitamins met in New York at the Hotel Pennsylvania. A special committee was appointed, including Dr. H. C. Sherman, of Columbia University (chairman); Dr. E. V. McCollum, of the Johns Hopkins University; Dr. Lafayette B. Mendel, of Yale University; Dr. Arthur D. Holmes, director of research, The E. L. Patch Company, Stoneham, Massachusetts; Dr. E. M. Nelson, of the U. S. Department of Agriculture; Dr. Charles E. Bills, director of the biochemical research laboratory of Mead, Johnson and Company, Evansville, Indiana, and Dr. Harry Steenbock, of the University of Wisconsin.

DR. WHITMAN H. JORDAN, who resigned as director of the New York State Agricultural Experiment Station at Geneva, N. Y., in 1921, after twenty-five years' service, died on May 8. He was seventy-nine years old. Dr. Jordan was director of the Maine State Experiment Station before going to New York in 1896 and before that was a professor at Pennsylvania State College.

DR. WARNER JACKSON MORSE died on March 25. He went to the Maine Agricultural Experiment Station in 1906 to head the department of plant pathology. In 1921 he became director of this institution and he held this title at the time of his death.

IRVING PORTER CHURCH, emeritus professor of civil engineering at Cornell University, died on May 7. He was eighty years old.

PROFESSOR HERBERT HAROLD WAITE, head of the department of bacteriology at the University of Nebraska, died on April 25, at the age of sixty-two years.

THE Botanical Society of New Orleans held its last regular meeting of the spring and summer on April 28, at Newcomb College, New Orleans. The following officers were elected for the coming year: *President,* Dr. Miriam L. Bomhard, department of biology, Newcomb College; *Vice-president,* Professor Wm. T. Penfound, department of botany, Tulane University; *Secretary,* Philip C. Wakeley, Southern Forest Experiment Station; *Treasurer,* Dr. L. J. Pessin, Southern Forest Experiment Station.

CHARLES H. TAYLOR, of the Boston *Globe,* was reelected president of the Boston Society of Natural History at the annual meeting on May 6. Other officers are: *Vice-presidents,* Nathaniel T. Kidder, Glover M. Allen and William M. Wheeler; *Secretary,* Clinton V. McCoy; *Treasurer,* Augustus P. Loring, Jr.; *Trustees,* Thomas Barbour, Joseph A. Cushman, William L. W. Field, Laurence B. Fletcher, Frederic H. Kennard and John C. Phillips. The Walker prize committee reported awarding first prize for this year to Arthur Sylhla, of the State College of Washington, Pullman, Wash., for a paper on "A Comparative Life History Study of the Mice of the Genus Peromyscus." Second prize went to Tzetuan Chen, 3905 Spruce Street, Philadelphia, for a paper on "Sympathetic Nervous System of Annelids." Because of the "marked merit" of the first prize paper, it was voted to increase the amount of the award from the usual \$60 to \$100. Second prize consists of \$50.

THE first regular meeting of the American Association of Physics Teachers was held at the Bureau of Standards in Washington on Thursday, April 30. The meeting was addressed by Dr. Albert W. Hull, assistant director of research at the General Electric

Company, on the subject, "Qualifications of a Research Physicist." The discussion was led by President Karl T. Compton, of the Massachusetts Institute of Technology. The attendance was about six hundred. A dinner and business meeting were held in the evening at which there was general discussion of the plans of the organization. The first annual meeting will be held in New Orleans in connection with the meetings of the American Association for the Advancement of Science, probably on December 31. The programs for this meeting are being arranged by the executive committee. Application has been made for affiliation with Section B of the American Association for the Advancement of Science. The association, which was organized at the Cleveland meeting, now numbers four hundred members. The campaign for increase of membership is continuing. Applications received prior to June 1 will result in enrolment of the applicant as a charter member. The secretary of the association is Professor William S. Webb, University of Kentucky, Lexington.

THE North Texas Biological Society, an organization made up of teachers and major students of biology and geology of a number of schools of North Central Texas, held a spring field meeting on May 1 and 2. More than sixty were in attendance at the meeting, which was held at the Worth Ranch Boy Scout camp in the Palo Pinto Mountains, west of Mineral Wells. The Friday evening program was given over to talks on the natural history of the region, while Saturday was spent entirely in field work. The plant students, under the direction of Professor Albert Ruth, of Fort Worth, dean of southwestern botanists, now eighty-seven years old, enjoyed particularly rich collecting.

THE reconstruction of the Royal Institution, in Albemarle Street, London, was celebrated on the evening of May 6 by a house warming, when guests were received by the president, Lord Eustace Percy, and the managers.

THE annual report of the National Institute of Industrial Psychology records that in every one of the many fields of the institute's activities 1930 has proved another record. Membership of the institute has increased from 1,430 to 1,600. The number of applicants for vocational guidance has increased by more than 50 per cent. compared with 1929. Investigations in factories, etc., have covered a varied field, and it is pointed out that "In a review of the past ten years the most satisfactory feature has been that not only have investigations been carried on for periods varying from one to eight years, but firms have come back to the institute for further help.

MR. SCOTT TURNER, director of the United States Bureau of Mines, estimated the total value of mineral products in the United States in 1930 to be approximately $4,795,000,000. This is a drop of about 18 per cent. from the total value of mineral products in 1929. Declines in values, accounted for both by lower unit prices and by the falling off in output of nearly all mineral products, are principally explained by the depression prevailing during the year in most lines of industrial activity. The total value of metallic products in 1930 decreased about 33 per cent., as compared with 1929. Notable decreases in total values, ranging from approximately 25 to 50 per cent., were recorded for copper, iron, silver, lead and zinc, but the value of gold production increased slightly. The total value of nonmetallic mineral products in 1930 decreased about 15 per cent. from the preceding year. Of the mineral fuels, the total value of natural gas increased, while the total values of bituminous coal, natural gasoline and petroleum recorded sharp declines.

DISCUSSION

UNDERTOW AND RIP TIDES

SEVERAL years ago I contributed an inquiry to these pages on the disputed subject of the undertow, which is supposed to drag surf-swimmers below the water surface and drown them. The inquiry aroused some discussion but brought forward little positive knowledge. One correspondent described a *surface* current, deflected off shore by a groin, as an "undertow," but without citing any evidence to show that it towed swimmers *under* water. Another implied a dangerous state of things in the so-called "rip tide" at Long Beach, a shore resort south of Los Angeles, California, by writing that, if I would come out there and try sea bathing, he would pay my funeral expenses; but apart from that tragic aspect of the case he gave no information whatever. One correspondent, a good swimmer, described a moderate, outgoing under-current that was felt outside of the surf in a small bay; such a current as one might suppose could be produced in compensation for an inward surface drift caused by a strong on-shore wind; but no on-shore wind or drift was mentioned. No one gave a careful description of an actual undertow that he had experienced, distinguishing it critically from the ordinary oscillatory movements of the water in the swell and surf near a beach; no one described an undertow as a recurring phenomenon, definitely related to the pattern of the shore and the form of the

bottom, or to the stage of the tide or the conditions of wind and weather. It seems reasonable, therefore, to regard the undertow as a somewhat imaginary quantity, the supposed occurrence of which depends largely on the excited sensations of poor swimmers. The fact that floating objects are not ordinarily carried in towards a beach suffices to show that no persistent under-current can be moving outward from it. Let it be understood, however, that a very real out-going movement takes place under the up-rush of the water from a breaking wave upon a sloping beach, for this is the compensating reflux of the preceding up-rush; but it is little felt outside of the line of breakers. Let it be noted also that, next outside of the breakers, the normal water movement of the water in a wave trough is outward; and that this movement is faster at the surface than at the bottom and that it is reversed to a shoreward movement when the next swell arrives. It has no significant under-dragging power. A real undertow should not be confused with these ordinary, systematic movements.

Now as to "rip tides." In the first place they are not to be confounded with "tide rips," such as are commonly seen in the waters around Cape Cod; for tide rips are simply standing waves caused by rather strong tidal currents running over a shallow bottom and increased by an opposing wind. Rip tides are something else, and they are regarded as extremely dangerous to swimmers at the above-named Long Beach; but just what they are is about as difficult to learn as to discover what the mythical undertow is. A recent number of the Los Angeles *Examiner* reproduced what is called an "amazing photo of a rip tide at one of the beaches" without specification of the locality; but the picture is so vague that little can be made of it, except that it shows a whitish patch as if of foaming surface water in the otherwise darker water. The accompanying text states that "the danger spots are rip tides—deep gullies between pairs of whirlpools—caused by winter storms. When the tide is going out, these have terrific dragging force and cast swimmers into the eddies. . . . Nearly all the beaches have rip tides at this equinoctial season, and bathers are advised to consult life guards before entering the water." If a bather is caught in a rip tide he is advised to swim with it, not against it, for he will then be "carried in a curving line back into shallow water."

From other reports that I have read there is no question that the Long Beach rip tides are fraught with danger, but their real nature remains obscure. If the above account of them is taken literally, a rip tide is not a current of water but a "deep gully between a pair of whirlpools, caused by winter storms." Moreover, "these [deep gullies?] have terrific dragging force and cast swimmers into the eddies"; yet a few lines farther on a swimmer is advised to swim with the rip tide, and thus "be carried in a curving line," not into an eddy or gully of terrific dragging force, but "back into shallow water." These irreconcilable statements are fair examples of what is commonly told about undertow as well as about rip tides. Surely, rip tides can not be excavations in the shallow sea floor caused by the storms of a preceding winter; they must be currents, probably of more or less curving, possibly of whirling or vorticular flow; and if such currents really have the terrific dragging force that is attributed to them, they and not the storms of a preceding winter may excavate the deep gullies that are said to be associated with them.

The shore at Long Beach is a long curve concave to the Pacific on the south; it has been cut back in several low bluffs of weak sandy strata, and its beach has been built across two or more shallow intervening embayments under the action of a west-moving back-set current, driven by the dominant southeastward current which is there held off shore by the peninsular promontory of San Pedro, farther west. The bottom deepens slowly, so that bathers may wade some distance from the beach before they have to swim. Motor boats are not rare thereabouts and it would seem that they might be easily used to determine just what a rip tide really is; but I have not been able to discover that any such study has thus far been made. A life guard whom I questioned on the beach during a brief visit two summers ago could give no clear account of what takes place when a rip tide is seen, or of the conditions which control its occurrence. Can any reader of SCIENCE give a clear account of these curious phenomena? Are they known and feared on other coasts, like that of Texas and New Jersey, as well as of southern California? Accurate information is much desired. My address from April to August will be 1351 Byron St., Palo Alto, Calif.

W. M. DAVIS

PALO ALTO, CALIFORNIA

NEW MASTODON FINDS IN EUROPEAN TURKEY

THIS note is a preliminary paper sent in now because it is all that can be done at present. Notes, photos and maps are available, and it is expected that a fuller account of the discoveries will be prepared for the *American Journal of Science* within the year, after the author returns home.

About twelve and fifteen miles west of Istanbul are two bays, Large and Small Chekmedje, drowned valleys, carved by streams since the last larger uplift of the region. The railroad from Sofia to Istanbul

nearly touches the head of each bay and follows the east side of Kuchuk Chekmedje its entire length as it comes down nearly to sea-level to enter the city. The stream coming into the latter bay from the north apparently was a part of a cavern or subterranean system. Its roof has collapsed, but four of its tributaries are still "lost streams," two on the west emerging from caves separately, and two on the east coming out at present essentially together.

The caverns on the east were human habitations and three burial sites are known on the slopes north of the cave mouths. Much more exploration is necessary before much of the truth in this matter can be written.

Farther south and between the two embayments in at least six localities, mastodon and other animal remains are found. The places are scattered over an area more than a mile north and south and nearly a mile east and west. The eastern bay has a western thumb and four of the localities are nearly in a line north from the thumb while the other two are between the thumb and the bay itself.

The parts known are not numerous but consist of 10 pieces. One is a mastodon tooth about 7 inches, front to back, 2½ inches wide and more than 6 inches high. Three tubercles of the tooth are worn through the enamel by use, but the fourth is still rounded. A second is a patella 3 inches across and much corroded. The third is a piece of tusk somewhat flattened and presenting a cross-section of about 4 by 6 inches. The layers show very clearly and are concentric round the nerve duct. This piece is more than one foot long, nearly white and clean. The other pieces are fragments of bone, apparently legs and ribs, and may not all belong to mastodons.

The discovery of these bones is due to the activities of Dr. Fikri Servet, a Turkish physician practicing in Galata Istanbul at Rasim Pasha Han 15–17. The doctor is a fine scholarly man and desires to collect farther and explore the cave more completely. He has done some excellent work so far and has given publicity in Arabic to some parts of his findings. He was anxious that a note be printed in English and this preliminary paper is in response to his request. Dr. Servet can be reached direct at his office or through the Istanbul Y. M. C. A., of whose board he is a valued member.

GEORGE D. HUBBARD

VEGETATIVE PROPAGATION IN THE MISSOURI GOURD

SOME time ago I noticed that young plants were common around the old plants of the Missouri gourd, *Cucurbita foetidissima,* though no fruits could be found. This made me suspect that they had some vegetative method of propagation. Two methods seemed probable; by formation of buds on the roots, or by forming roots at the nodes which might survive and form new plants.

No nodal roots could be found at the time, but later in the season such roots appeared towards the ends of the numerous vines. The first root on a vine was often 10 to 12 feet from the parent root. Usually but a single root formed at a node, but sometimes two or even three were found. Several of the nodes towards the tip of the vines would form roots.

These roots soon thicken, forming successive rings of bundles somewhat as in the beet. These bundles are small, parenchyma cells filled with starch making up the bulk of the root. By fall they were about a half inch in diameter and looked something like a parsnip. Contraction of the roots tends to draw the vine into the ground at the point of attachment.

I have marked a number to see if they survive the winter, though I have no doubt that they do, as larger roots not attached to the large vines with small vines of their own are common. These were probably formed the preceding summer but may be older.

In the arid places where this plant usually grows such a method of propagation would be a great advantage, as seedlings would only be able to become established in favorable seasons. Even this method might fail in dry years.

So far I have found no mention of this method of reproduction in the literature and wonder if it has been overlooked.

N. F. PETERSEN

LINCOLN, NEBRASKA

MEIOSIS IN HYPERICUM PUNCTATUM LAM.

THE cytology of the *Hypericum* species of New England and vicinity is being studied and will be reported later. It seems well, however, at this juncture to make a brief summary of meiosis in *Hypericum punctatum* Lam. The chromosome behavior in the development of pollen resembles very closely the condition reported by Cleland[1] and others for certain species of *Oenothera.* The development up to diakinesis is very similar. At no time does there appear an extended approximation of threads. Like *Oenothera* the spireme appears univalent and as Cleland remarks seems to call "for a telosynaptic interpretation." After the second contraction there emerges a chain, or chains, of chromosomes fastened end for end like sausages. There are sixteen in all. So far no complete rings or paired chromosomes have been observed as noted in *Oenothera.* Otherwise it might be mistaken for a species of the latter. During the first division the chromosomes show the same tendency to have the alternating ones pass to opposite poles.

[1] R. E. Cleland, "Meiosis in the Pollen Mother Cells of *Oenothera biennis* and *Oenothera biennis sulfurea,*" *Genetica,* 11: 127–162, 1926.

There are irregularities, however, as in *Oenothera*, and haploid plates of seven and nine, instead of the usual eight, are not uncommon. At maturity there is always a large percentage of morphologically sterile pollen. The peculiar arrangement of chromosomes seems to be of special interest and so far has been noted in no other *Hypericum*.

CARL S. HOAR

THOMPSON BIOLOGICAL LABORATORY,
WILLIAMS COLLEGE

SOFTENING TISSUES

IN the paper, "A Method to Soften Tissue Already Imbedded in Paraffin," which appeared in SCIENCE on December 12, 1930, it should have been stated that the work was done entirely in Dr. Linford's laboratory, and that it was at his suggestion that I tried the water soaking to soften the pineapple leaf.

A. B. COUCH

CHAPEL HILL, N. C.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

USE OF AN IMPROVED NULL INSTRUMENT FOR GLASS ELECTRODE OR OTHER HIGH RESISTANCE CIRCUITS

SEVERAL authors have described vacuum tube amplifiers for use with glass electrodes, employing radio-type vacuum tubes in circuits arranged to secure stability and sensitivity. But in even the best of these the grid current of the tube is large enough to cause polarization of the glass membrane or there are other difficulties.

A new vacuum tube has recently been described by Metcalf and Thompson.[1] This tube, the General Electric Pliotron FP 54, was especially designed for the detection of minute D.C. currents and potentials, and its use for this purpose has been discussed by Du Bridge.[2] The grid current is so small (10^{-15} amperes) that it introduces negligible errors in the measurement of potentials of systems of very high resistance. For instance, the writer has found that glass electrodes with resistance as high as 100,000 megohms may be used in the grid circuit of the tube with no difficulty. The measured potential of a standard cell in series with this value is the same as when obtained directly. When an electrode of 10,000,000 megohms was used, and allowance was made for the IR drop across it, the correct value of the standard cell was obtained within one tenth of one per cent. Using a Compton electrometer, hitherto the best instrument available, no reading at all could be made in series with this 10,000,000 megohm resistance.[3, 4]

The usefulness of this vacuum tube is obvious. It makes possible the use of thick glass membranes of small area, simplifying the drop method of MacInnes and Dole[5] by permitting the use of thicker and more rugged glass membranes. For measurements where larger quantities of liquid are available, bulb electrodes may be blown with such thick walls that they can be handled almost as roughly as test-tubes, and their resistances will be entirely negligible for this measuring instrument. The validity of the glass electrode as a hydrogen electrode is discussed in the papers by MacInnes and Dole,[5] who also give the composition of a suitable glass.

A diagram of the circuit used is given in Fig. 1. The amplifier is entirely enclosed by a heavy sheet-

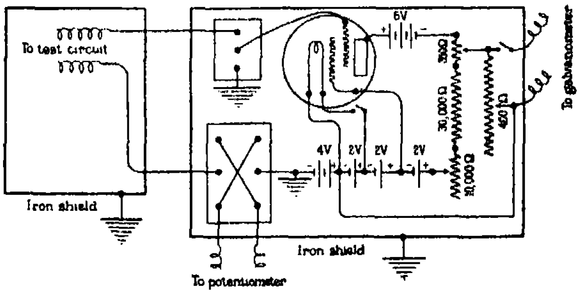


FIG. 1. Circuit for measuring D.C. potentials in high resistance circuits with the General Electric Pliotron FP 54. Batteries are lead storage cells. Resistances are wire-wound. Shielding is galvanized iron.

iron shield, and the test circuit also is carefully shielded, all shields of course being grounded. The designers of the tube recommend large storage batteries for all potentials in order to avoid drift of the

[1] G. F. Metcalf and B. J. Thompson, *Phys. Rev.*, 36: 1489, 1930.

[2] A. Du Bridge, *Phys. Rev.*, 37: 392, 1931.

[3] Mr. D. Belcher, of the Rockefeller Institute, kindly tried making measurements in series with these high resistances with the Compton electrometer.

[4] This vacuum tube is also a useful instrument for measuring extremely high resistances. The flow of the grid current (10^{-15} amperes) through a resistance placed in the grid circuit will cause a change in potential of the grid. From the simple equation $E = IR$, the value of the resistance may be determined. The grid current of the tube may thus be used for measuring resistance above 10^{11} ohms when the plate circuit galvanometer has a sensitivity of 0.01 micro-ampere per millimeter (permitting detection of one-tenth millivolt). Measurement of resistances below 10^{11} ohms of course calls for current from some external source, and is carried out in the usual manner.

[5] D. A. MacInnes and M. Dole, *Jour. Gen. Physiol.*, 12: 805, 1928–29. *Ind. and Eng. Chem.*, 1: 57, 1929; *Jour. Am. Chem. Soc.*, 52: 29, 1930.

galvanometer. The sensitivity of the instrument depends largely upon the galvanometer. For measuring to one tenth millivolt the writer has found adequate a galvanometer with a sensitivity of 0.01 micro ampere per millimeter. In use, the grid is grounded, and the plate resistance adjusted until the galvanometer reads zero. The grid is then connected to the circuit under test and the potentiometer adjusted until the galvanometer again reads zero. The potentiometer reading, of course, gives the E.M.F. and polarity of the test circuit.

Some of the earlier papers upon glass electrode circuits lay unnecessary emphasis upon insulation difficulties. Only ordinary care need be used except in the grid circuit of the tube. The potentiometer reversing switch is in the low resistance portion of the grid circuit and may be of almost any material and may be outside the shield with the potentiometer. In the high resistance part of the grid circuit extraordinary care must be taken that there are no insulation leaks to shunt the tube. The wire leading from the glass electrode to the grid should be shielded (a flexible copper shielded wire has been found excellent) and the single pole double throw switch for grounding or charging the grid should be the best available. The writer used a telephone "anti-capacity" switch, in which the manufacturer's black bakelite mounting was replaced by transparent bakelite, which was used also for the roller. It was found necessary to bake this transparent bakelite for two days at 115° C. in order to make its insulation good enough. Amber might, of course, be used but is more expensive. The handle of this switch was grounded in order to avoid any body charge from the operator. When glass electrodes of extremely high resistance are used, there is an initial deflection of the galvanometer on closing the switch, due to the capacity of the test circuit. The charge due to this capacity difference leaks off in a few seconds. The 400 ohm shunt resistance for the galvanometer reduces the initial deflection, and the shunt is then opened to secure full sensitivity.

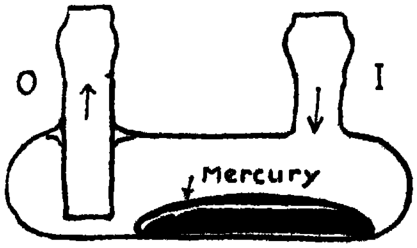
The shield for the external circuit was a cage of ¼ inch mesh iron wire, which was found adequate. Inside the iron cage, the electrodes and other apparatus were held in iron clamps attached to ½ inch bakelite rods screwed into laboratory tripods. No special treatment was needed for the bakelite rods if the clamps holding the electrodes were as much as six inches apart. The bakelite rods were occasionally cleaned with alcohol and ether. In general, greater care should be taken with the insulation and shielding of the grid circuit than with an electrometer circuit, since this is a more sensitive instrument. This vacuum tube circuit is cheaper and more portable than the Compton electrometer. The Lindeman electrometer, which is portable, has the disadvantage of a low sensitivity, and must be read with a microscope. For those unaccustomed to the use of vacuum tube amplifiers, the small amount of time required to master this simple circuit will be more than compensated for by its superiority to any other method of measuring potentials in high resistance circuits.

SAMUEL E. HILL

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK, N. Y.

A TILTING STOPCOCK

I HAVE made and used for some time a simple stopcock which corresponds exactly to the convenient mercury switch for electric current, and which can be used in the same way for cutting positively a flow of gas under small pressure, without any danger of leak and without friction. It can be mounted like the mercury switch, that is, well balanced on a light axis, so that the slightest effort will cut off the supply of one or more Bunsen burners. I found it a great help



whenever automatic regulation of gas supply was needed. The accompanying sketch will make its construction and functioning clear. One must always connect the tubes in such a way as to have the gas enter the stopcock through inlet I. As soon as the stopcock is tilted, the mercury obstructs the outlet O, and the flow is cut off. On coming back to horizontal position, the gas resumes its flow.

P. LECOMTE DU NOÜY

INSTITUTE PASTEUR, PARIS

SPECIAL ARTICLES

A MOTTLED-EYED DROSOPHILA

EARLY last December a gray red-eyed female fly was found that had notched wings and an area of white facets covering the lower fourth of the left eye. The fly appeared in the F_1 generation from a cross of a treated Theta male to an untreated female

having a ClB chromosome and a second X-chromosome carrying the mutant genes for yellow, white, lozenge and miniature. The single X of the Theta male had the mutant genes for yellow and scute at the left end, and a duplicated fragment attached to its extreme right end. The attached fragment is a deleted element from another X-chromosome, and has the wild-type allelomorphs for yellow, scute and broad from the left end, and the gene for bobbed (probably) from the right end. Breeding tests with this female showed that the case belonged to the so-called "eversporting" mottled type, and that mottled eyes and notched wings varied independently of each other in their phenotypic expression.

A rather extensive series of genetic tests has been carried out on this stock, but the detailed results will not be published until some later time. In this note we desire to indicate briefly some of the main points brought out in the study, and especially to suggest an explanation for the ever-sporting character of mottling and notching, as exhibited in this particular strain of flies. All the results are consistent in support of the following explanation: A piece of the left end of the treated Theta X-chromosome has been broken off and has become attached to a fourth chromosome (IV). The translocated fragment contains the mutant genes for yellow and scute and the wild-type allelomorphs for prune, white, facet echinus, and its length must therefore be greater than five and a half map units.

In the first cross made with this mottled-eyed female the Theta fragment was removed from the broken X-chromosome by a crossover. The stock has since been maintained by mating mottled-eyed females to yellow white singed males. It was found that a female zygote receiving the yellow white singed chromosome and the broken X, together with the translocated fragment, may develop into a normal yellow female (non-mottled, non-notched). But in case the fragment becomes eliminated from any cell (or cells) during morphogenesis, the descendants of this cell will produce, in combination with non-deficient cells, somatic tissue exhibiting mosaicism—mottled eyes, or notched wings, or both, depending upon whether cells that have lost the fragment happen to enter the embryonic rudiments of these structures. If the F_1 mottled females from such a cross are back-crossed to yellow white winged males, there are found among the F_2 off-spring males and females that are hyperploids.

The non-crossover hyperploid female has two yellow white singed X-chromosomes and the translocated fragment. She is therefore singed and red or mottled eyed, but never has notched wings. The non-crossover hyperploid male has the yellow white singed X-chromosome and the fragment. He is also singed and red or mottled eyed. The hyperploid males constitute the only class of males that show mottled eyes. A few yellow scute males appear in the cultures. This type of male has the broken X-chromosome and the translocated fragment. Such a male is never mottled eyed, because (apparently) the loss of the fragment during development results in the death of the zygote.

Linkage tests for the translocation demonstrate that the fragment is attached to the fourth chromosome. Cytological studies made by one of us (Painter) also reveal the presence of the fragment on the fourth in a female heterozygous for the translocation (a fact discovered before the linkage tests were completed). The metaphase plates of oogonial divisions show that the attached piece is about three times the size of a fourth chromosome (Fig. 1, a, b). In the nervous tissue of the same female larva, heterozygous for the translocation, cells have been found that show the translocation, while other nearby cells have normal fourth chromosomes, thus demonstrating that the translocated piece may actually become lost during morphogenesis.

FIG. 1, a and b.

From this brief account it will be seen that the mosaicism in this strain of flies is due to an *unstable translocation*. From the view-point of cytology, the case is of interest in that it gives us an opportunity to compare the physical size of the left end of the X-chromosome with its corresponding genetic or map size.

J. T. PATTERSON
T. S. PAINTER
UNIVERSITY OF TEXAS

THE EFFECTS OF X-RAYS ON THE GROWTH OF WHEAT SEEDLINGS

THE present study was undertaken to obtain quantitative results on the reactions of growing plants to x-rays under controlled biological and physical conditions. Wheat seedlings were used because preliminary experiments showed that the growing parts were relatively sensitive to x-rays and because the results under similar conditions were in close agreement. The roots elongate at the rate of about 1.3 mm an hour. Over two hundred thousand measure-

ments were made on the control and irradiated material during a period of three years.

The source of radiation was a standard water-cooled Coolidge tube. The filament current was maintained at 30 ma., and a potential of 200 kv. was applied across the tube. A copper filter 0.9 mm in thickness was interposed between the tube and the seeds. To prevent evaporation the dish was covered with a thin sheet of bakelite. The distance of the seeds from the center of the target was 43 cm. Before and after, as well as in the middle of each experiment, ionization readings were taken to check up any variation in the energy output of the machine.

In preparing an experiment the dry seeds were carefully washed in distilled water and left soaking in it for 3.5 hours. Then they were "planted" in moist chambers (diam., 23 cm; depth, 7.5 cm) on filter paper moistened with distilled water. When the seeds were not being handled they were kept in a practically light-proof incubator, the temperature of which was maintained at 26° C. Twenty-four hours later the coleoptile, the leaf and the two lateral roots were all about 2 mm long, while the primary root had grown about 5 mm.

At this time seedlings for irradiation were selected. Only those in perfect condition and uniform in length were chosen. They were placed side by side for treatment in a large petri dish. After irradiation the seedlings were removed and placed in the petri dishes (diam., 15 cm), twenty being distributed in each dish. The bottom of the dishes was covered with two layers of filter paper wet with 15 cc of distilled water. These, together with the control dishes, were then put in the incubator, where they were left undisturbed until removed for measurement forty-eight hours later.

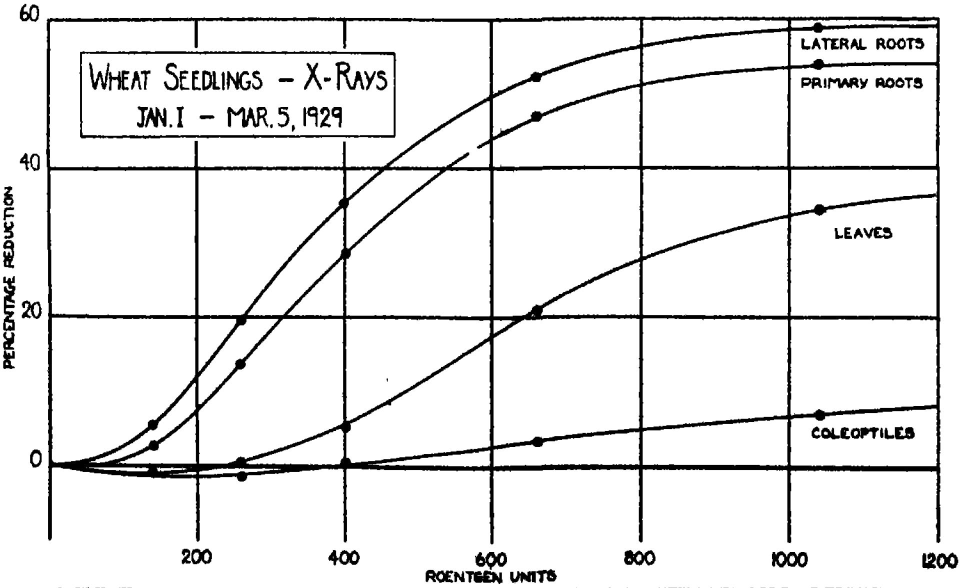
The growing parts were measured by placing them on a millimeter rule, their length being read to an assistant who recorded the figures on an adding machine.

The results may be summarized briefly:

(1) The seedlings are relatively sensitive, less than a threshold erythema dose reducing the growth of the lateral roots to half the normal length.

(2) Each of the four growing parts of the seedling are affected to a different degree by the same dose. This fact is brought out clearly by the accompanying curves. A threshold erythema dose reduces the growth of the coleoptile less than 3 per cent. Taking the percentage reduction of the coleoptile (with reference to the control) as unity, and comparing it with the other growing parts, these differences are found:

Growing part	Relative effect
Coleoptile	1
Leaf	6
Primary Root	16
Lateral Roots	18



THE EFFECTS OF X-RAYS ON THE GROWTH OF WHEAT SEEDLINGS

Each point is the average of 560 measurements, except in the case of the lateral roots where each point is the average of 1,120 measurements. The ordinate represents the percentage effect in terms of the control. For example, if the normal primary root grew 100 mm, while the treated root grew 60 mm, the "percentage reduction" in growth would be 40. The abscissa represents the dose in r-units. A threshold erythema dose is equal to 600 ± 5 per cent. r-units.

(3) In general the curves show that as the dose is increased it produces relatively less effect. This holds true for each of the growing parts. A dose of 1,000 *r*-units reduces the growth of the primary root 53 per cent.; 8,000 *r*-units reduces the growth only about 60 per cent.

(4) Differences between the controls and the irradiated seedlings can be detected a few hours after treatment. In general these differences become greater as the period between treatment and measurement is lengthened. The forty-eight hour period was chosen because the effects of the x-rays were pronounced at this time, and because the methods of seedling cultivation used would not have been so satisfactory had a longer period been adopted.

(5) *Within the range studied it was found that* when the product of the intensity and time of exposure is kept constant the effect produced is the same. The intensity can be cut down to 1/12 and the time of treatment increased twelve times without noticeably changing the biological effect.

(6) Seedlings which are heavily irradiated exhibit abnormalities. Instead of tapering gradually to a delicate slender tip, the roots are thickened throughout their whole length. At the end there forms a tuberous enlargement, the diameter of which is two or three times that of a normal root. The coleoptile becomes tough and much thickened, especially at its base.

(7) The growth-promoting vitamin B in the embryo is destroyed by heavy doses. The physical conditions in this phase of the work were identical with those in the other experiments except that the copper filter was omitted and the time of exposure was increased to 120 minutes. This dose is approximately 72,000 *r*-units. It requires one per cent. of embryo in a vitamin-B-free synthetic diet to sustain normal growth in a young albino rat. A similar diet containing 6 per cent. of irradiated material does not permit normal growth. I am under obligations to Dr. Kanematsu Suguira, who carried out this work in his laboratory.

Packard has brought out the fact that the effect of x-rays on *Drosophila* eggs is independent of the wavelength. Other investigators have found that short or long x-rays are more effective in inhibiting the growth of different organisms. Because of these conflicting results, extensive parallel experiments were carried out using low potentials of between 40 and 50 kv. After the completion of the work, however, new measurements showed that the graphite chamber used measured only a proportion of the energy of the soft radiation. Further interpretation of these data, therefore, must await the calibration of the graphite chamber with a standard ionization chamber.

The writer is under obligations to the physical department of the hospital for providing the apparatus and for making the physical measurements.

WARE CATTELL

BIOPHYSICS LABORATORY,
MEMORIAL HOSPITAL,
NEW YORK, N. Y.

RESPIRATION STUDIES ON AZOTOBACTER UNDER CONTROLLED CONDITIONS

SINCE the discovery of *Azotobacter* by Beijerinck, considerable work has been done on their physiology. As a result of the free energy data published by Lewis and Randall, the interest in these organisms has recently centered on the energetics and mechanism of the nitrogen fixation process. Careful studies on the rate of respiration over the entire range of oxygen tension is of utmost importance and is indispensable when the nitrogen fixation process is considered thermodynamically.

To measure the metabolic activity of *Azotobacter* at different partial pressures of oxygen, the rate of formation of carbon dioxide and the heat energy evolved was measured at the same time. The differential calorimeter built by Randall and Rossini[1] was

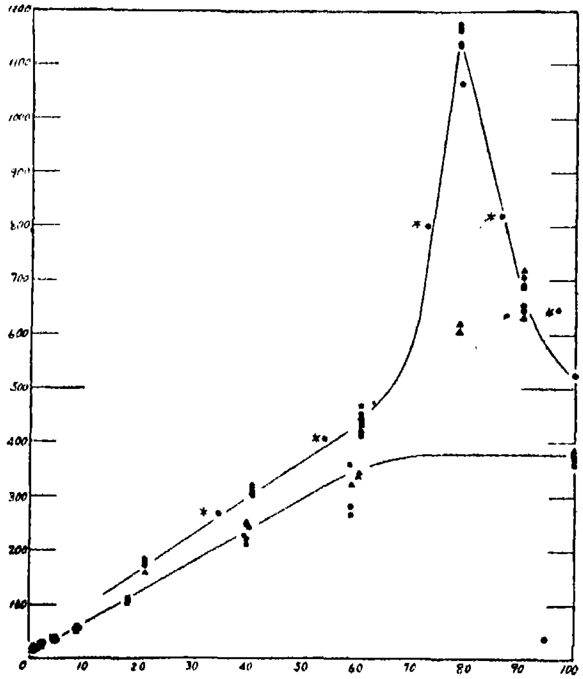


FIG. 1

Ordinate represents the calories produced;
Abscissae, the per cent. oxygen.
▲ Calories per hour measured.
● Calories calculated from the carbon dioxide evolved.
* These points represent the carbon dioxide evolved during 1 hour, 20 minutes of which the oxygen tension was at the lower value and at the higher value for the remaining 40 minutes. The average oxygen tension is therefore the lower tension plus two thirds the difference between it and the next higher oxygen tension.

[1] *Jour. Am. Chem. Soc.*, 51: 325, 1929.

reconstructed so that the culture could be aerated vigorously with preconditioned carbon-dioxide free gas, which was conveyed through alkali towers where the carbon dioxide evolved was adsorbed and measured. Twelve hundred cc of a 24-hour culture of *Azotobacter chroococcum* in a nitrogen free medium was transferred aseptically to the previously sterilized calorimeter. Aeration and mechanical stirring was at once started and the heat and carbon dioxide measurements made.

In every case where equilibrium with respect to the gas phases was maintained the same results, as shown in the figure, were obtained. The rate of respiration remained constant at 78 per cent. oxygen for 4½ hours. The oxygen concentration was between 60 and 90 per cent. oxygen for 6½ hours as shown by eight carbon dioxide determinations. It is interesting to note from the nitrogen fixation standpoint that the oxygen-nitrogen ratio (78 per cent. oxygen), that gave the maximum rate of respiration, is the same as it is in the nitrate ion.

The data just reported are not in accord with those published by Meyerhof and Burk.[2] They measured the rate of respiration of a culture of *Azotobacter* over the entire range of oxygen concentration by the Warburg[3] method. They found the rate of respiration to increase with increasing oxygen tension up to 15 to 20 per cent. oxygen, above which the rate of respiration rapidly decreased until it was from one third to one half that of air at 100 per cent. oxygen. In their experiments the ratio of the gas confined above the culture to volume of culture was about 6 to 1 and the total volume of the apparatus was 12 cc. The gas did not bubble through the medium. The author found it difficult to effectively remove the carbon dioxide at the higher oxygen concentrations when the carbon dioxide free gas bubbled continuously through the mechanically stirred culture at the rate of 20 to 22 liters per hour. This was found to be true even when the ratio of carbon dioxide free gas to the volume of culture was 15 to 1. In some experiments, it was necessary to increase the ratio to 18 to 1.

It is quite possible that the method used by Meyerhof and Burk to remove the carbon dioxide from the culture and to supply oxygen adequately is extremely inefficient and totally unreliable, especially at the higher oxygen concentrations.

J. M. Fife,
National Research Fellow in the Biological Sciences
Division of Plant Nutrition and Department of Chemistry,
University of California

[2] *Zeitschr. f. physikalische Chemie*, Abt. A, 139; *Bd. Zeit.*, 117–142, 1928.

[3] "Stoffwechsel der Tumoren," Julius Springer, 1926.

THE NATIONAL ACADEMY OF SCIENCES. II

Examples of the uncertainty principle: C. G. Darwin (by invitation). This principle asserts that a simultaneous measurement of the position and momentum of a body can only be carried to a certain degree of accuracy. In the present work an electron is supposed to be at rest, and its position is to be measured by the electric force it exerts on an electrometer. It is shown that the electrometer will exert a reactive force so as to set the electron in motion to just the degree required by the principle. Further examples deal with magnetic forces and with the impossibility of measuring the magnetic moment of the free electron.

The distribution of stresses in welded and riveted connections: William Hovgaard. This paper describes a new method for determining the stresses in a line of weld or rivets and the adjoining structures when the connection is subject to shearing in its own direction. Consider first the elementary case of a bar or narrow plate attached to a plate of greater length and width. We refer to the minor structure as the "bar" and to the major structure as the "plate." Suppose that the plate is subject to elongation due to a simple uniform pull at its ends, then the bar is forced to follow due to shearing in the weld or rivets which connect it to the plate; but it is clear that the bar will resist elongation and that there will be a certain elastic creeping of the bar relative to the plate. Thus every section of the bar will suffer a displacement relative to the corresponding section of the plate, but by symmetry this displacement is zero at the middle, and it is obvious that it will increase to a maximum at the ends of the bar. The assumption is made that the displacement at any transverse section is equal to the shearing stress at that section multiplied by a constant, which we call the "displacement coefficient." The theoretical solution of the problem is obtained by variation of the integral expressing the internal elastic work and furnishes a very simple expression for the shearing stresses in the connection, as well as for the average tensile stresses in the bar and in the plate. The proposed method finds application to several important cases in naval architecture and civil engineering. *Deckhouses* fitted on the strength deck of a ship near the half length where great bending stresses are apt to occur will be in a position similar to that of a bar connected to a strained plate. No shearing stresses will exist at the middle of the deckhouse in its connection to the deck, but excessive shearing stresses are liable to be found at the corners of the deckhouse, and have in fact occurred in many cases. The usual remedy of cutting the deckhouse in two or more sections connected by

"expansion joints" is liable to aggravate the difficulties by multiplying the points of discontinuity. The remedy is an increase of rivet area and strengthening of the structure at the corners of the deckhouse. *Large hatch openings* in strength decks produce discontinuities which in their effects are quite similar to those produced by deckhouses. It was this action which caused tearing of the deck in the *SS. Majestic* and *SS. Leviathan*. In certain *oil tankers* short intercostal longitudinal girders are fitted to the bottom plating between the transverse bulkheads, to which they are not connected. In each of these girders great shearing stresses are apt to occur at the ends, and may cause leaky rivets. *The cover plates on the chords of bridge girders* are in the same position as the typical bar described above, being riveted to a major strained structure.

The equidimensional convention for electro-magnetic units: A. E. KENNELLY. It was shown by Maxwell fifty years ago that every physical quantity had dimensions, *i.e.*, exponents of length, mass and time. Thus a velocity, being a length divided by a time, has dimensions $L^1\ T^{-1}$, or including mass $L^1\ M^0\ T^{-1}$. He showed also that every electromagnetic quantity had two dimensional formulas —one in the electric system and the other in the magnetic system of units. Thus electric resistance had dimensions of velocity $(1, 0, -1)$ in the magnetic system and the dimensions of inverse velocity or slowness $(-1, 0, 1)$ in the electric system. In 1889, Ruecker showed that electric permittivity κ and magnetic permeability μ necessarily entered into the dimensions of electric and magnetic units along with L, M and T in Maxwell's list. The dimensions of κ and μ are not definitely known, except that their product $\kappa\mu$ is $1/v^2$, the square of the slowness of light. Ruecker added to Maxwell's list of three dimensions in L, M, T, a fourth, using κ in the electric and μ in the magnetic list. On the convention that κ and μ have like dimensions, each that of a slowness, a remarkable simplification takes place in the lists of electromagnetic dimensions. The κ and μ elements disappear, and the electric list coincides with the magnetic list. In other words, there remains one and only one list of electromagnetic dimensions, in terms of L, M and T only. Moreover, the exponents of L, M and T in the resulting list are in each case the arithmetical means of the two series of exponents in Maxwell's electric and magnetic lists. This single equidimensional series is thus also a mean series, which becomes so much condensed and simplified that it is easily memorized.

Relations between nuclear spin, hyperfine structure and isotopes: R. C. GIBBS and P. G. KRUGER (introduced by Edw. L. Nichols). Out of about twenty-six elements with odd atomic numbers whose spectral lines have been examined for structure the lines of twenty-four of them have been reported to have hyperfine structure. Out of about twenty elements having even atomic numbers absence of structure in the lines of ten of them has been reported. Most of the remaining ten elements whose lines exhibit hyperfine structure consist largely of even isotopes, being practically 100 per cent. so in several cases. Two theories, the second a modification of the first, have been advanced to account for the observed results. First, a spin moment of $1/2 \cdot h/2\pi$ is assigned to each proton and electron in the nucleus. These when compounded vectorially give a resultant moment of $i \cdot h/2\pi$ where i is called the nuclear spin quantum number and may assume values of 0, 1/2, 1, 3/2, 2 . . . , the odd half values resulting when the sum of protons and electrons in the nucleus is odd and the even half values, including zero, when that sum is even. When i is quantized with J, the resultant quantum number of the extra-nuclear electrons, an energy level corresponding to a given value of J is replaced by two or more very close levels thus giving rise to hyperfine structure in the radiated lines. When i is zero no structure should be found. So far no structure has been found in the lines of Ag, yet the sum of protons and electrons in the nucleus of Ag atoms is odd. Except for the doubling of certain F levels observed in one multiplet, though not found in another multiplet involving the same levels, the same is true of Al. Possible values of 1 and 2 have been reported for i in the case of Sb. This theory would predict only odd half values. A study of nitrogen band spectra indicates that i should be 1, yet the nucleus of N contains fourteen protons and seven electrons, giving a sum that is odd. So far no definite evidence has been reported as to the value of i determined from the hyperfine structure of N lines. These exceptions, particularly the last one, led to the suggestion that only the number of protons in the nucleus is effective in determining the value of i. With this suggestion, the available data, though rather meager and inconclusive, are in conflict, especially those for Tl and Pb. If we accept this modification, then we should expect to find even half values for i for such elements as Ne, Te, Xe, Ba, Hg, Pb, and Tl. All these elements are known to have lines with hyperfine structure, many of the components being comparatively strong. Some of these elements have only even isotopes and in no case is the percentage of odd isotopes large. A study of the hyperfine structure of lines from these elements has been undertaken with the hope of obtaining critical data with which to test the theory. Such information will help to solve the problem of nuclear structure.

Electric conductivity and optical absorption in metals: EDWIN H. HALL. (1) The resistance term in Drude's fundamental equation of motion of an electron within a metal is highly artificial, for light-wave fields, and any conclusions to which it leads are affected by some measure of doubt. (2) The form which this equation takes when it is applied to a conduction electron is quite as appropriate for an electron that passes directly from an atom to an adjacent ion as it is to a "free" electron. (3) The conduction electrons which Meier (in 1909) found to be about as numerous as the atoms may reasonably be taken to be the "associated" electrons, the electrons that may execute "transits" from an atom to an adjacent ion. (4) The formula $\kappa \frac{\sin^2 n T}{n^2 T^2}$, given by Thomson on page 84 of his "Corpuscular Theory of

Matter,'' when applied to ''transit'' conductivity gives the same results as those obtained in a different way by the author, indicating that when the ratio *wave-period to transit period* drops from 10 to 1, the absorptive power of the transit electrons drops from 97 per cent. of its maximum value to zero. (5) Meier's results, obtained with wave-lengths ranging from 250 $\mu\mu$ to 670 $\mu\mu$, seem to indicate that for wave-lengths of 4 μ or greater the transit electrons should have almost their full, steady-current, conductive power and a corresponding absorptive power. (6) Hagen and Rubens, using wave-lengths 4 μ, 8 μ and 12 μ, got for metals and alloys in general results which seem to indicate that the absorption-conductivity is somewhat less than the steady-current conductivity at all three wave-lengths, the difference being about 12 per cent. at 4 μ, about 1.6 per cent. at 8 μ and about 9 per cent. at 12 μ, with no clear evidence that it would disappear at greater wave-lengths. In the case of bismuth the difference is exceptionally large. (7) This difference, which is hardly to be accounted for by the ordinary theory of the relation between conduction and absorption, may be due to some imperfection of the experimental method used by H. and R. On the other hand, it is worth noting that the dual theory of conduction requires a difference of the kind and of the order of magnitude here observed. For this theory makes the paths of the few free electrons last so long that the rapidly alternating fields of even the longest light-waves would have no net effect upon them. Therefore, it confines the conduction-absorption power of metals to the action of the ''associated,'' or ''transit,'' electrons, and for metals in general the conductivity due to these electrons is about 8 or 10 per cent. less than the total conductivity. For bismuth K_a is exceptionally small, about 67 per cent. of the total K.

An incandescent filament giving a discontinuous spectrum and a study of the emission and absorption of neodymium: R. W. WOOD. The theory of radiation predicts that a substance raised to a high temperature by a flame or electric current will emit no light if perfectly transparent, the emitting power being in proportion to the ability of the substance to absorb light. If the absorption is selective for color, as in colored glass, for example, it should radiate strongly only those colors which it is capable of absorbing. No very striking examples illustrating this phenomenon have been found, however, due chiefly to the circumstance that a very small trace of absorption is all that is necessary to make the body a good radiator, colored glasses giving a practically continuous spectrum when heated to incandescence. A remarkably fine example illustrating the law most strikingly has been found, however, by dissolving oxide of neodymium in fused quartz, in the flame of an oxy-hydrogen blow-pipe. The fused mass is drawn out into thin rods, and these, when raised to incandescence in the flame of a bunsen burner and viewed through a prism, exhibit a spectrum consisting of blue, green, orange and red bands separated by perfectly dark regions. A rod of pure fused quartz, being almost perfectly transparent, is practically non-luminous in the flame, the introduction of the oxide producing absorption in the green, orange and red regions with corresponding powerful emission of these colors. More bands have been discovered by photographing the spectrum of the filament with plates sensitive to the infra-red region, there being nine bands in all, counting the four in the visible spectrum. A somewhat complete study was made of the absorption spectra of neodymium salts at liquid air temperature and in solution in anhydrous liquid ammonia, in which the absorption split up into narrow components.

Stereoscopic three-dimensional models by multiple photography with especial reference to the orbital motion of the electron in the Stark effect: R. W. WOOD. A method was described by which complicated stereoscopic models could be built by multiple exposures with a stereoscopic camera focussed on a wire frame painted white and strongly illuminated in front of a black background. This wire frame is moved slightly in appropriate manner, between each exposure, its images building up a three-dimensional model resembling a complicated wire cage when the finished picture is viewed in a stereoscope. The method has proved very useful for illustrating certain mathematical and physical problems which can not be shown by simple diagrams. The shape of the wire frame can be altered as it is moved or rotated between exposures, or small objects (electrons for example!) moved into successive positions along the wires of the frame, giving a picture of their complicated orbital motions in certain spectroscopic phenomena.

The spectral erythemic reaction of the human skin to ultra-violet radiation: W. W. COBLENTZ, R. STAIR and J. M. HOGUE. The spectral erythemic response curve of the untanned human skin and the energy required to produce a mild erythema are of importance in connection with the question of the unit of dosage and methods of standardizing the dosage of ultra-violet radiation used for healing purposes. The present paper gives new data on the spectral response of a small group of subjects differing widely in erythematic susceptibility. The experimental procedure consisted in irradiating the inner forearm with a monochromatic spectral line and, from a succession of exposures, selecting the one that produced a minimum perceptible erythema. The spectral erythemic response curve obtained by this method is in agreement with observations obtained by other methods. The energy required to produce a minimum perceptible erythema upon 1 sq. cm. of untanned human skin, using monochromatic radiation of wave length 297 mμ (the wave length of maximum erythematic susceptibility), is of the order of 500,000 ergs.

The temperature of the atmosphere of the earth: E. O. HULBURT (introduced by Joseph S. Ames). If the amounts of the various gases of the atmosphere of the earth were known at all levels from sea level upward, if the absorption coefficients of the gases were known throughout the optical spectrum and if the sun were assumed to be the only source of energy, it should be

possible to calculate for all heights the temperature of the atmosphere in radiative equilibrium. This problem has never been worked out completely. Maris (Terr. Mag. and Atmos. Elect. 33, 233, 1928; 34, 45, 1929) recently obtained an approximate solution and derived a number of important conclusions from calculations of the rates of energy absorption and radiation in various levels of the atmosphere. In the present paper an attempt at a fairly rigorous solution is presented, although it contains a number of approximations. By considering the stream of radiation sent upward from the earth, which is heated by the sun, and from the atmosphere and the stream of radiation sent downward by the atmosphere an equation is derived for the temperature of radiative equilibrium. From this equation the temperature of the atmosphere from sea level upward is calculated and is found to agree fairly well with the observed sea level value, 14° Centigrade, averaged over the earth. The agreement may be regarded as a proof that the sea level temperature is approximately that of radiative equilibrium. From 5 to 20 km above sea level the equation yields temperatures which are below those observed. This is as it should be, for calculation shows that in these levels the temperature is not that of radiative equilibrium, but is mainly that of convective equilibrium caused by wind mixing. In higher levels, above 30 km, radiation is probably the controlling factor, as Maris has already shown in detail. If the total amount of carbon dioxide in the atmosphere were doubled or halved, the calculated sea level temperature is increased or decreased, respectively, by about 6°. Such a change in the average world-wide temperature, augmented by the consequent changes in the water vapor content of the atmosphere and the infra-red emissivity of the surface of the earth, is about the same as that which occurs when the earth passes from an ice age to a warm age. Therefore our conclusion is in support of the carbon dioxide theory of the ice ages originally suggested by Tyndall (*Phil. Mag.* 22, 277, 1861). We do not agree with the arguments advanced against the carbon dioxide theory of the ice ages by Angström, Abbot, Humphreys and others. It is hardly necessary to mention that we have not proved that carbon dioxide changes actually caused the ice ages; we have merely shown that, as far as we know now, carbon dioxide changes would have been adequate to cause such ripples in the thermal life of the earth.

Deformation of the Pensacola shore line: FRANK LEVERETT. In a paper presented at the annual meeting in 1930 the part of the Pensacola shore line near Tampa, Florida, was described by the writer and the view expressed that it is sufficiently well preserved to warrant setting its age as not greater than that of the Algonquin beach of the upper Great Lakes, or some 20,000 years or less. This determination was of value in showing the relatively recent date of extinction of certain Pleistocene vertebrates, such as the mastodon and camel and the giant sloths whose remains have been found in close association with those of man in stream channels on the plain below the Pensacola shore line. During the past six months the writer has studied this shore line in the states bordering the Gulf from Florida westward to Louisiana and has found that it decreases in altitude from east to west, being about 40 to 45 feet above present sea-level on the Atlantic coast of Florida, 33 feet on the west coast near Tampa Bay, 25 feet at Pensacola, 22 feet on Mobile Bay, and less than 20 feet on the north side of Lake Pontchartrain. Inasmuch as it becomes lower toward the Mississippi delta, the question naturally arises whether the weighting by delta deposits has been a leading cause of the decline in that direction. Or if not the cause of this wide-spread tilting, to what degree has it produced local effects? To clear up this matter, it seems necessary to study some neighboring shore lines, such as those of Cuba, which are outside the probable range of influence of the delta deposits, and determine whether they show a similar westward decline. If so, it would seem likely that the westward tilting of the shore line in these states is largely independent of the delta's influence.

Paleontology versus DeVriesianism and Genetics in the Factors of Evolution Problem: HENRY FAIRFIELD OSBORN. Forty years ago the American Museum instituted a new method of collecting fossil mammals in the rich Tertiaries of the West, namely, of very close observation of geologic levels and the closely succeeding transitions of form to form or ascending mutations in different phyla or lines of ascent, especially in certain lines of ascent, the horses, the Titanotheres and the Eocene primates. These closely connected stages mirror the evolution of the germ plasm and afford an entirely new and hitherto unknown and even undreamt of progressive and creative heredity. This progressive and creative heredity is set forth in the recent monograph on the Titanotheres as a result of hundreds of thousands of observations and is confirmed and greatly extended in the forthcoming monograph on the creative evolution of the Proboscideans. These well-established principles of progressive and creative heredity are not in accord either with Lamarckism or Darwinism or DeVriesianism or any form of vitalism or entelechy. They are even more directly opposed to the theoretic conclusions recently drawn by experimentalists in genetics as the most recent phase of the Darwinian doctrine of the survival of chance variations. In adaptations which are primarily chemical and depend on sudden alterations in chemical compounds, as in the origin of immunity and non-immunity, there is scope for sudden saltations from type to type. In adaptations which are primarily physical there is less likelihood of sudden mutation. In adaptations which are primarily mechanical sudden mutation is not only theoretically improbable but empirically without the least foundation. Consequently, the known factors of germinal evolution discoverable through paleontology alone are absolutely contrary to recent DeVriesian and genetic hypotheses.

Emotional differences connected with certain signs of race: G. M. STRATTON. In the more critical studies hitherto of the psychology of race, the chief objects of

interest have been the senses and the intellect. Tests of intelligence, for example, have for some years been finding an important application in this field. The present paper, in contrast, is concerned not with intelligence but with emotion—an aspect of our mental life which may in the end prove to be highly important in determining the relative effectiveness of different races and nationalities. By a method described in detail in the *American Journal of Psychology* (Vol. 39, pp. 125–40), a gradation has been made of the anger reactions and the fear reactions of a considerable number of Caucasians in California. And of the same persons, measurements were made of the length and width of their heads, and observations made by which each individual could be classified as to the color of his eyes and the shade of his hair. Computations based on these data indicate a connection between the physical features which are often taken to be signs of race, and the intensity of the emotional reactions in the various groups. A group of persons with narrow heads, for example, may not show the same degree of emotion as does a group with a different cephalic index. And similarly of groups differing markedly in shade of hair, or in color of eyes. The general similarity in the environment of the various groups suggests that the emotional differences may in the main be innate, rather than due to training, and may be the result of a difference in the psycho-physiological endowment of different racial strains.

Inheritance in the tailed form of Chilodon uncinatus—a mutation obtained by use of ultra-violet radiation: MARY STUART MACDOUGAL (introduced by Lorande L. Woodruff). Seven modifications of *Chilodon uncinatus*, obtained by use of ultra-violet radiation, have been described. These include a triploid, a tetraploid and a tailed form which has lived for eighteen months. The homozygous strain, after thirty epidemics of conjugation, shows no reversion to normal. Twelve out of two hundred conjugating pairs of the heterozygous race became normal, and have never shown any sign of an appendage, while eight homozygous pairs were obtained. Two out of the two hundred pairs lost their tails, but retained the changed body shape and ciliation. They were weak, and died after three divisions each. Four out of two hundred pairs showed normal form and ciliation, but had a short tail. This is a hardy race, and, after two conjugation epidemics, no normals have been observed. In a mixed culture of the homozygous and normal races, it was observed recently that for the first time there was wholesale attempt at conjugation. One member of each of the fifty pairs isolated was already dead, though fused to the living member, and none survived the effects of conjugation. Attempts to cross the heterozygous and normal form with a tail with the normal form have been more successful, and these experiments are now under way.

The body temperature and heat regulation of large pythons: FRANCIS G. BENEDICT and EDWARD L. FOX. The large snakes, as other cold-blooded animals, have a temperature regulation entirely different from that of man or other warm-blooded animals. In the latter the mouth or trunk temperature is the highest and the skin temperature somewhat lower, but in practically all cases the body temperature is materially above the air temperature. With snakes the body temperature in the mouth and the cloaca is practically the same, in spite of the fact that it is a long, stretched-out animal. The skin temperature is a little lower than the body temperature. Under ordinary conditions when the snake is quiet and not digesting food, the body temperature and the skin temperature are somewhat lower than the environmental temperature. With activity, such as in the agitated, striking snake, there is a considerable rise in body temperature, because the snake can not lose heat as fast as it produces it. After such a period of agitation the body temperature is several degrees above the initial temperature. During digestion there is likewise a rise in temperature, especially noticeable over the lump where the body of the animal eaten is being digested. These studies show that the most important factor in the temperature regulation of snakes is the vaporization of water. Although the snake has no sweat glands, its entire body gives off water by diffusion. A considerable amount of water is thus lost, in addition to that in the breath, and the entire heat produced by the animal is used in vaporizing water. Indeed, in some cases, such as in hot climates, the snake may actually absorb heat from the air and use this heat to vaporize water. As a result, the snake may be compared in a way to the wet bulb thermometer, the temperature of which is lowered below that of the environment by the continual vaporization of water from the wet fabric around the mercury bulb. With warm-blooded animals about 25 per cent. of the heat produced is lost in the vaporization of water. With the snake and other cold-blooded animals practically the entire amount of heat produced is thus lost.

BOOKS RECEIVED

CAMP, BURTON H. *The Mathematical Part of Elementary Statistics.* Pp. xxi + 409. Heath. $3.60.

CONWAY, A. W., and J. L. SYNGE, Editors. *The Mathematical Papers of Sir William Rowan Hamilton.* Volume I: Geometrical Optics. Pp. xxviii + 534. Cambridge University Press, Macmillan. $20.00.

FORD, ADELBERT. *Group Experiments in Elementary Psychology:* Students' Manual and Notebook. Pp. vi + 241. 55 figures. Macmillan. $1.25.

HEGNER, ROBERT W. *College Zoology.* Third edition. Pp. xxiii + 713. 568 figures. $3.50. Laboratory Guide for College Zoology. Pp. viii + 75. $1.00. Macmillan.

LYDE, LIONEL W. *The Continent of Europe.* Pp. xv + 456. Illustrated. Macmillan. $4.00.

NORTHROP, F. S. C. *Science and First Principles.* Pp. xiv + 299. 6 figures. Macmillan. $3.00.

OSBORN, HENRY F. *Cope: Master Naturalist.* Pp. xvi + 740. 30 figures. Princeton University Press. $5.00.

STAIG, ROBERT A. *The Fabrician Types of Insects in the Hunterian Collection at Glasgow University.* Part I: Coleoptera. Pp. xv + 110. 28 colored plates. Cambridge University Press, Macmillan. $8.50.

WARMING, EUGENIUS, and PAUL GRAEBNER. *Lehrbuch der Ökologischen Pflanzengeographie. Dritte Lieferung.* Bogen 31–45. Pp. 481–720. 101 figures. Verlag von Gebrüder Borntraeger, Berlin.

WHYTE, L. L. *Critique of Physics.* Pp. xi + 196. Norton. $3.00.

SCIENCE

VOL. 73 FRIDAY, MAY 22, 1931 No. 1899

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE RECENT CHANGE OF ATTITUDE TOWARD THE LAW OF CAUSE AND EFFECT[1]

By Professor P. W. BRIDGMAN

HARVARD UNIVERSITY

NEARLY every educated person, brought up in present-day society and under the influence of the scientific ideas and spirit which pervade our intellectual life, prides himself in the belief that nothing happens without there being some cause for it. We may briefly characterize this attitude of ours by saying that we believe in the law of cause and effect or in the causality principle. To many of not too cynical a temperament this attitude will seem the most sweeping characteristic of the mental difference between the superstitious savage and the cultivated product of a hard-won civilization.

It is now becoming common knowledge that one of the most startling developments of the altogether surprising progress of physics in the last few years has been a weakening of the belief of the physicist, at least, in the validity of the causality principle. I want to examine with you this situation—to inquire in what sense we are losing our conviction of the validity of the causality principle, and to discover some of the implications. I want especially to emphasize that I am concerned only with the objective aspects of the situation. The idea of causality which we shall discuss is as remote as possible from the subjective questions of free will or determinism which are often associated with it, both in popular discussions and in a number of recent more technical discussions by scientific men. We shall be concerned only with the domain accessible to experiment, and the causality principle, in the sense in which I use the term, is a principle dealing with the findings of actual experiments.

[1] Address delivered at the University of Wisconsin, April 21, 1931.

We shall not be able to get very far without trying to make a little more precise what we mean by the causality principle. What do we mean in any concrete situation by saying that the event A is the cause of the event B? There is at least one obvious condition to be satisfied; B must occur later than A, for no one would think of saying that something happening now was the cause of something which had already occurred in the past. But mere sequence in time is not enough. For instance, in society as at present constructed one's education is almost always completed before embarking on the sea of matrimony. But do we therefore say that the cause of our getting married is that we are educated? That is, there may be sequences in time which we recognize as due to accidental and irrelevant associations. What more, then, is necessary than mere sequence in time? I believe that examination will show that we must at least have invariable sequence—the event B must always follow the event A under all sorts of conditions. But this involves being able to repeat the experiment, and it seems to me that the idea of invariable recurrence on repetition is indeed essentially involved in the notion of causality and perhaps comes closest to what is usually meant by causality. For example, suppose that I have a heavy weight attached to a support by a string; then I shall find that whenever I cut the string the weight falls, so that my definition in terms of invariable sequence would lead me to assert that the cause of the falling of the weight was the cutting of the string. But the situation is not quite as simple as this, for in the repetition of the experiment as ordinarily performed a number of the conditions are not varied, and who shall say that some one of these invariable conditions is not responsible, and therefore the true cause, of the weight falling? For instance, if I could by some heroic means remove the earth, then we are all convinced that the weight would no longer fall when the string is cut, and so we could justify the contention that the true cause of the falling of the weight was not the cutting of the string but the presence of the earth. But a still more critical analyst might contend that even the presence of the earth would not be sufficient to make the weight fall if it were not for the law of gravitation, and that therefore the true cause of the weight falling is the law of gravitation.

An impartial examination of the various arguments would convince us that there is much to be said for each of them; if we should decide that one of the claimants was correct and the others wrong, I think we should find it impossible to defend our decision against the objections of the losers. This sort of dilemma occurs very frequently. Sometimes one tries to save the day by the introduction of such ideas as that of immediate and remote or primary and secondary causes, but no such compromise ever works satisfactorily, as may be seen in our simple example by selecting some definite feature as the primary cause of the falling of the weight, to the exclusion of all others.

The conclusion to be drawn from these difficulties is, I think, that the notion of causality is not sharp and can not be made logically precise, but it is only a common-sense notion, used in describing many situations of daily life with sufficient accuracy for ordinary needs. I believe that analysis will show, however, that all situations which may be described from the common-sense point of view as those to which the law of cause and effect applies have certain more general properties. Whenever our knowledge of a situation has become sufficiently deep for us to attempt an analysis of its various events into cause and effect, we find that we have merely had sufficient experience with the situation to observe certain uniformities of behavior, certain regularities in the sequence of events, of the sort that when certain events occur other definite events follow. This characteristic of uniformity I take to be the fundamental feature in the situation. The analysis of events into sequences which are causally related is simply one of the ways of exhibiting certain uniformities and recurrences.

What now is the criterion that in a given physical system one has mastered the essential uniformities and has not merely stumbled on something accidental? I think that every one will admit that the supreme test is the ability to predict; if our neighbor is always able to accurately predict the future behavior of any physical system, I believe that we should all admit that he had completely mastered the uniformities of the system. Conversely, I think that we shall easily admit that without uniformities in the past behavior of a system no conceivable basis for predicting the future exists. The essential thing, however, is the ability to predict; granted this we have comparatively little concern with the language or system of philosophy in terms of which our neighbor may choose to describe his feelings in the matter. Furthermore, we shall all, I think, admit that in a system completely governed by the law of cause and effect the future should be predictable if we know the complete past history of the system, and conversely, if we know how to predict the future from the past, we should expect to be able to formulate some sort of statement as to the uniformities of the system which could be put into the form of a law of cause and effect.

It appears, then, that uniformity, causality and predictability all have certain common aspects, and

for rough purposes may be treated as more or less equivalent. It will suit the purposes of this exposition to lay the emphasis on predictability and I shall in the future be concerned with this aspect of the situation. We may now reformulate our statement of the beginning that nearly every civilized person believes in the law of cause and effect by saying that nearly every civilized person believes that the future of a system is in principle predictable when we know all about its past behavior. To avoid argument, I am perfectly willing to make the qualification that this discussion shall be limited to the realm of purely inanimate things, leaving out altogether biological phenomena.

As a historical fact, classical physics has been committed to a much more restricted formulation of the possibilities of prediction in stating that the future could be predicted if the present position and velocity of each particle is known. This conviction arose from the belief that the laws of Newtonian mechanics, which can be formulated in terms of differential equations of the second order, completely govern the motion of the actual physical universe. This formulation, however, is much more restricted than we need to make it for our argument and in fact there are difficulties with the Newtonian conception of predictability when attention is paid to various propagation effects which are discussed in elementary expositions of relativity theory. The essence of the situation for our purposes is that we have become convinced that the behavior of nature exhibits regularities of such a kind that from observation of the events of the past we can predict those of the future.

What now is the basis of this belief of ours in the thorough-going uniformity of nature or in the essential predictability of future events? It must at once be admitted that this belief in its wide-spread acceptance is largely an outgrowth of the last few hundred years. Savage and superstitious man sees in nature nothing but the capricious; it is only after long experience and observation that the simple uniformities begin to emerge, first the regularities in the motions of the heavenly bodies and then the same regularities in the simpler terrestrial mechanical systems. It was a tremendously stimulating discovery to find that simple uniformities in the motions of the planets which could be formulated in simple mechanical laws recurred also in the motion of terrestrial systems, and to find that as we acquired skill in analyzing systems of increasing complication these same simple uniformities continued to describe the uniformities being newly discovered. It is no wonder that after physics had experienced success after success in mastering systems of increasing complication it came to look on this success as no accident but the expression of an underlying principle. In some such way arose the conviction of the essential uniformity and predictability of nature; it was of course recognized that in the walks of daily life, as distinguished from the artificial situations of the laboratory, the power to predict was more conspicuous by its absence than its presence, but this was ascribed merely to the enormous complication of actual physical systems, and the conviction became general that by sufficiently refining the accuracy of our measurements and increasing their scope we might some day hope to reduce the most complicated system to predictability with any desired degree of accuracy.

It is to be emphasized that although the justification for this conviction arose entirely from experience of the external world, it constituted, nevertheless, even in the simplest possible case, an idealization of that experience. For in any concrete physical situation a prediction about a future event could be verified only within the limits of experimental error. The conviction that the future is predictable down to the last detail arose entirely from the experience that whenever the precision of measurements was increased the predictions which it was possible to make on the basis of the measurements always became better. But the uncertainty arising from experimental error could never be eliminated, and even in the most favorable cases the jump from the actual experiment to the ideal formulation of it involved a process which the mathematician or the physicist would describe as a long range extrapolation.

But now in the last few years all these expectations have changed, and the change has arisen primarily from the discovery of new experimental facts. Nothing previously found by experiment ceases to be true. Physics never has to retract statements about experimental facts when these statements are made with sufficient care to reproduce the physical situation with fidelity, that is, when due regard is paid to the limits of experimental error. Thus the law of gravitation should not be formulated baldly as the law of the inverse square, but rather that the attraction varies as the inverse square within certain limits of error, perhaps one part in a million, or whatever the greatest precision happens to be at present. The only genuine retractions which physics or other science has to make are in its statements about what it anticipates may in the future be found to be true about experimental realms not yet entered. So in the present situation, physics finds that it must retract a hope or expectation which it had based on previous experience, but it has not had to retract any statement about actual experiment. The expectation was that by increasing the accuracy of measurement indefinitely we would be able to make predictions about the future

with indefinite precision. This turns out not to be true, for we have recently found that when we increase the refinement of our measurements beyond a certain point and enter a domain of small things not before accessible, the new domain is full of the most capricious irregularities, unlike the regularities in the domain of ordinary experience, so that in the new domain no refinement of measurement enables us to predict the future. The new domain in which this disturbing state of affairs holds is the domain in which the motions of single electrons or atoms are concerned, and is, of course, enormously remote from the domain of everyday affairs, in fact, so remote that only within the last few years have physical methods been sufficiently refined to enable us to enter this domain at all. The situation is not unlike that presented by the semi-convergent series of the mathematician. Situations are not uncommon in mathematics in which the goodness of the answer to a problem may be improved up to a certain point by increasing the labor of computation, but if labor is put into the calculation beyond this point the answer becomes poorer instead of better.

Our new understanding of the experimental situation can be made in the following bald statement: "As a matter of fact, events are not predictable in the realm of small things." This is practically equivalent to saying that in the realm of small things the law of cause and effect does not operate.

Some little experience has proved to me that this bald statement is likely to awaken in many persons the most active hostility, and this audience would indeed be unique if it did not contain an appreciable number of persons who positively bristle with animosity at such a statement. The reaction which this statement is most likely to produce is this: "You have not proved that in the realm of small things the future is not predictable, but all you are justified in saying is that you have not yet found how to predict the future. In fact, judging by past experience, there is every reason to think that if we keep on trying we shall eventually discover how to predict in this domain which at present seems so hopeless." This objection, I am sure, will appeal to many as entirely sound, but I believe that nevertheless it can not be maintained, and one of the points which I am most anxious to make this afternoon is my reason for thinking this position not to be sound. I hope that the positiveness of the assurance of the physicist in this matter will not give the unpleasant impression of mental arrogance which it easily might. I believe that every physicist recognizes that one can never say with complete assurance that his present theory is correct. There is nevertheless at least one statement which, when it can be made at all, can be made with absolute assurance, and that is that we are now taking into consideration ideas which had not previously occurred to us. All that the physicist is maintaining is that we have now at our command new experimental facts and new ideas and that in the light of them our former ideas must be modified.

It must be conceded that certain parts of the objection of our bristly critic are well taken. We have not, of course, proved that the future is not predictable, and we can say only that we are not at present able to predict and do not believe that we shall ever be able to. In fact, in the very nature of logic, it can never be proved that an entirely unexpected discovery may not be made some day which will enable us to predict the apparently unpredictable. We shall have to admit that from this point of view the tactics of the objection is very clever. From another point of view also the tactics is clever in that it puts the burden of proof on the advocate of the new point of view in effectively asking him "by what right do you expect that no one ever will find out how to do what to-day we do not know how to do?" I believe that nevertheless, in spite of the superficial strength of the objection, it is fallacious.

Let us in the first place examine what the experimental situation is which leads us to say that events in the realm of small things are unpredictable. When, in the domain of large things, we fail to predict, it is usually because of the extreme complication of the physical system, as, for example, in our endeavors to predict the weather or mob psychology. In the domain of small things, however, the element of complication is lacking and our failure arises from another reason. The reason we fail is because those regularities which are the basis on which we are able to make predictions in the simpler situations of large scale experience are entirely lacking in the domain of small things. Let us imagine the simplest possible large scale situation—a billiard ball rolling without friction or other interference on a table top. Let us imagine the table top marked with lines a foot apart. Then we all know that if we observe the ball to be at the zero mark when the second hand of our watch points to zero, and to be at the one foot mark when the second hand points to one second, when the second hand points to two seconds we shall find the ball at the two-foot mark. This is the simplest example well conceivable in which we project into the future a uniformity of behavior in the past, and, parenthetically, is doubtless the origin of the ordinary concept of velocity. But experiment shows that if we were dealing with an electron instead of a billiard ball the experiment would entirely fail, and if the electron had been observed at zero at zero seconds and at one foot at one second, at two seconds we might s

find it at seven feet and sometimes at five feet, or sometimes at minus one foot, and indeed sometimes at two feet, like the billiard ball. As a matter of fact this ideally simple experiment probably has not been performed, but inference from the results in less simple cases leads us to be convinced that such would be found to be the state of affairs if the experiment were made.

If capricious results like those just described for the electron happened in the experiment with the billiard ball we would almost certainly say that the initial conditions had not *all* been the same the time the ball appeared at the seven foot mark as when it appeared at five feet, and we should endeavor to find something that we had failed to take proper account of in specifying the initial conditions. Furthermore, we are convinced that this procedure would be successful in the case of the billiard ball, and that search would disclose the missing feature. We are also convinced that it would need some rather striking feature to account for the billiard ball sometimes turning up at seven feet and sometimes at five feet. But in the case of the electron, all our experience indicates that the missing feature does not exist, but that in systems in which the initial conditions are completely identical the electron will sometimes appear in one place and sometimes in another. Anything more unlike ordinary experience would be difficult to conceive, and the consequence is that there is very little basis indeed for making a successful prediction of the future position of an individual electron.

The experimental evidence, then, apparently forces us to the conclusion that if some basis for predicting the behavior of a single electron is to be found, it must be entirely different from the basis of prediction for ordinary events. Why is it that the majority of physicists at present believe that there is good reason to think that this basis for prediction will never be found, but that on the contrary we shall always have to treat the motions of single electrons as beyond the reach of prediction, that is, beyond the law of cause and effect? The reason is not that the physicist is either lazy or a quitter. Part of the reason is rather to be found in the quite surprising success achieved within the last few years by that body of physical theory variously described as "quantum theory" or "wave mechanics." The very foundations of this theory contain as an integral part the hypothesis that the individual electrons, as also the indivisible units of radiation, have the fundamental property that in any specific situation their behavior as individuals can not be predicted, but only the average behavior of large numbers. One explicit deduction from the theory which is directly concerned with predictability has been much discussed, namely the Heisenberg Principle of Uncertainty. This is usually formulated as a statement about the accuracy of measurement, the fundamental idea being that if we strive to increase the accuracy with which we make one kind of measurement we must pay a price in a necessary decrease in the accuracy of some other kind of measurement. Specifically, I can not measure the position and the simultaneous velocity of the electron with any desired accuracy, but if I increase the accuracy of my measurement of position, my measurement of velocity becomes less accurate in such a way that the probable value of the product of the two inaccuracies is of the order of magnitude of Planck's constant, h, divided by the mass of the electron. The principle applies equally well to the measurement of the position and velocity of an ordinary body. The reason why the principle is important for the electron and not for ordinary bodies is that the mass of the electron is so very much less than that of any ordinary body that when I divide Planck's constant, h, by the mass of the electron I get a comparatively large number, that is, a comparatively large uncertainty, whereas the quotient of h by the mass of an ordinary body is so much smaller as to represent an uncertainty below ordinary methods of detection.

The Heisenberg principle, as I have just formulated it, does not seem to make statements about predictability, but that it really does may be seen by considering the significance of the velocity about which we are talking. To make the problem concrete, go back to the moving electron. If I observe it at the one-foot mark at a certain time and then one second later at the two-foot mark, I know that its velocity during this second was exactly one foot per second. It is not this velocity with which the Heisenberg principle is concerned, and indeed the Heisenberg principle sets no limit to the accuracy with which this velocity may be determined. The velocity with which the Heisenberg principle is concerned is the velocity to be ascribed to the electron after, not before, the second observation. Now the only way I have of checking whether any statement about this second velocity is correct is to predict where I shall find the electron at a later instant of time. If the Heisenberg principle is correct, this prediction can not be made with precision; we thus see that the Heisenberg principle is really a statement about the impossibility of accurately predicting the course of the electron.

There is a point here which it will pay to emphasize because there has been considerable misconception about it. The *modus operandi* by which the uncertainty gets into the situation is through the act of observation—the electron can not be observed without bouncing an atom of radiation from it or doing some-

thing equivalent, and whatever the process of observation, the motion is interfered with. The essential fact is not that the act of observation interferes with the motion; if this were the only effect we could allow for the amount of interference by calculation. The essential fact is that the act of observation interferes with the motion by an unpredictable and incalculable amount. The fact that the amount of interference is unpredictable is an integral part of the theory.

Those persons who for one reason or another are anxious to save the face of the causality principle have often stated the conclusion from the Heisenberg principle in another way. They say that the causality principle is still valid, only it turns out that we are unable to make the measurements which are demanded in applying the causality principle, that is, in making a prediction. This contention it seems to me may easily degenerate into a mere matter of words, and become highly unprofitable. The essential fact is that it appears to be due to a law of nature and not to any temporary failure of ours that we can not make the measurements that we demand for our attempted predictions. In this situation it seems to me that we are keeping as close as possible to the actual facts in making the bald statement that experiment now makes it highly improbable that the future is predictable.

Not only is the Heisenberg principle checked by experiment, but apparently all other deductions from the wave mechanics theory are also checked with equal success. In fact, the success of the theory has been so great that the statement is often made by its enthusiastic advocates that in no case where it has been correctly applied, that is, without blunders in the calculation, has it failed, and that no experimental facts are known which are in contradiction with it. The average physicist now takes the next step, and draws the conclusion that because of the success of the theory the fundamental hypotheses on which it rests must also be very probably correct. It must be admitted that this last step is rather dubious from the logical point of view, because it does not follow at all that because our conclusions are correct our reasoning or our premises must be correct, and in fact there are a number of instances in physics in which the fundamental hypotheses have been changed without changing at all the superstructure, as shown, for example, by the change in attitude toward the physical reality of the ether.

I think we would have to admit that if the sole argument of the physicist were the success of the theory as at present formulated we would have some ground for scepticism as to how long the present attitude would last. But the physicist has other reasons for his attitude. Along with his experimental activity he has been active in critically examining the fundamental concepts of physics. Among other things he has examined the grounds on which rest our conviction that nature is uniform or predictable and has come to the conclusion that at least the burden of proof is now on the side of those who maintain that nature is uniform and can be described in terms of a causality principle. The reasons for this conclusion I have already intimated, but they are worth repeating. The physicist recognizes that belief in uniformity or predictability is a belief compelled by no inner necessity, but is a belief that has gradually grown up as a generalization from large scale experiences; that as long as experience was confined to the large scale things of daily life an ever increasing number of phenomena could be brought under the approximate sway of the principle, but that as soon as physical methods became sufficiently refined so that we could deal with small scale phenomena, uniformities became less and less conspicuous, until we finally arrived at electrons and photons, the ultimate structural elements of the physical world as we know it, where we would expect the utmost in the way of simplicity and uniformity but where, on the contrary, experiment shows that uniformity in its original sense has entirely vanished.

The situation thus contains two elements: There is in the first place the recognition that the notion of causality, in the sense in which I am using it, was an outgrowth of experience, and that the extent to which the causality principle is valid is solely for experiment to decide. This attitude I believe must now be accepted by every one who will take the pains to examine the argument. In the second place there is the conclusion from experiment that as a matter of fact nature is very far from predictable or that the causality principle fails by large amounts to be valid for small-scale events. If the first point is accepted, then the second may be accepted as a summary of the best experimental knowledge at present, without resentment or antagonism or rebelliousness. This willingness to accept the findings of experiment must remain permanently a part of our attitude, whether or not future experiment justifies present optimism about the complete adequacy of wave mechanics. This, then, is the chief idea that I hope you will carry away from this talk; that it is purely a matter for experiment to decide whether nature is predictable in the domain of small things or not; that until some at present totally unlooked-for development turns up to prove predictability or to make it plausible, we must assume that the causality principle does not apply in this domain, and that this conclusion is to be accepted without prejudice or passion just as any other experimental result is accepted.

What difference is the recognition of this situation now going to make to us? As far as actual action in most concrete situations of daily life go, it will make practically no difference at all. Large-scale phenomena will remain for all practical purposes just as predictable as they ever were. The reason for this is that in no case have we ever been able to predict large-scale phenomena with more than a certain degree of approximation; the goodness of the approximation has been fixed by the accuracy of the measurements. Furthermore, in nearly all cases, the inaccuracies of our measurements arise from the ordinary imperfections of our instruments, recognized and well understood long before the Heisenberg principle was formulated, and these inaccuracies are so great that the uncertainty in our predictions arising from them is much greater than the uncertainty arising from the action of the Heisenberg principle. In most practical situations the Heisenberg uncertainty is so very far beyond the reach of detection by ordinary means that from the practical point of view its effects will in nearly all situations remain forever of purely academic interest.

There is a difficult point here which we may stop to examine for a moment. At first sight it is not easy to see how it is that if large-scale phenomena are built up from small-scale phenomena and if the small-scale phenomena are essentially unpredictable, the large-scale phenomena acquire approximate predictability. The reason is that although any single small-scale phenomenon is unpredictable, experiment shows that nevertheless there is a sort of regularity in large numbers of them which permits combinations of them to be predicted, approximately. This sort of regularity is of the sort that may be described as statistical. Let us go back to the illustration of the electron moving over the marks on a table, and let us suppose that the electron has been observed at the zero mark at the zero of time and at the one-foot mark at one second. Then it is a matter of experiment that if I attempt to predict where the electron will be found at two seconds I shall make a great many mistakes, but it is also a matter of experiment, neglecting a consideration which is not important for this argument, that if I always guess that it will be at the two-foot mark, I shall in the long run make fewer mistakes and obtain a better score than if I make any other guess. There is thus a certain regularity in the aggregate results of a great many experiments, although the results of individual experiments may fluctuate widely, being now greater than the average and now less. If I could make a great many experiments simultaneously, it is evident that I could make a good prediction about the average result of all of them taken together, because in a great many experiments those individual results which are too high will cancel with those which are low, leaving outstanding merely the average. Something very much like this is involved when experiments are made on ordinary matter, for even the smallest bits of matter that can be distinctly seen in the microscope still contain a very large number of electrons, and the behavior of the whole bit of matter is merely the average behavior of all its electrons, which can therefore be predicted with much success. In fact, as already stated, the mean fluctuations arising from the uncompensated fluctuations of the individual electrons are less than the uncertainties arising from other and more ordinary sorts of imprecision of measurement.

It might seem, therefore, as though there could never be any practical effects arising from such small-scale uncertainties. This, however, would be too hasty a conclusion. If one makes the deliberate attempt, it is possible to magnify such small-scale events sufficiently to bring them into the range of everyday experience. An example of this sort of thing is known to every physicist in the Geiger counter. This apparatus is so constructed that the effect of the entrance of even a single electron into the sensitive part of the apparatus is amplified with vacuum tubes to such an extent as to give a crack of sound in a loud speaker, or to perform other functions, such, for example, as starting or stopping a piece of machinery. Now the electron which enters the apparatus may be the result, for example, of the radio-active disintegration of a single atom. The disintegration of such an atom is the sort of thing that experiment and theory both show is essentially unpredictable. It would therefore be possible, by utilizing an arrangement of this kind, to make all the lights of a great city flicker up and down, and it would be absolutely impossible to predict when the next eclipse would occur.

Some of you may have read a recent story by Lord Dunsany in which a crazy power magnate wards off the vengeance of the powers above by gigantic prayer wheels driven by 10,000 horse power steam turbines. We may similarly romance about the future religion of a superstitious race by imagining in the inmost shrine of their temple a speck of radio-active salt in process of disintegration, and attached to this a train of vacuum tube amplifiers, which shall ever and anon flood the temple with light, or beat a tom-tom, or perhaps sacrifice a victim. A rather good argument might be made for this sort of thing, and it really appeals to the imagination in many ways, for we have here the possibility of a spectacular projection into the realm of ordinary sense of the eternally inscrutable foundations of our physical world.

In the realm of ordinary physical objects, however, this sort of unpredictability probably seldom occurs

unless it is the result of deliberate design. It is not quite so evident, however, what the true state of affairs is in biological systems. I gather the impression that at the present time a number of biologists are prepared to admit that not infrequently the adjustment of a single cell may be so delicate as to be thrown out of balance and a reaction started by the entrance of a single free electron or light corpuscle into the cell. In such cases the behavior of the individual cell must be admitted to be unpredictable. In one simple field of biological experiment the facts have already been definitely established. It has been shown that when certain unicellular organisms are radiated with alpha particles, the death of the organism results if a single alpha particle makes a direct hit on the nucleus of the cell. The death of any single organism is therefore an absolutely unpredictable event, although in a large colony of such organisms the average number of deaths may be predicted by the methods of life insurance statistics. The important question now is whether in large-scale organisms consisting of many cells the adjustment is ever so delicate as to be thrown one way or the other by the unpredictable action of only a few cells, or whether so large a number of cells must cooperate in any large-scale movement as to make all large-scale movements approximately predictable by the methods of statistics. This question can be answered only by experiment, and it is certainly one of the most important questions to which biology can address itself. At the same time it is obviously one of enormous experimental difficulty, for no experiment can be repeated under identical conditions on an organism complicated enough to have memory.

A word of warning may be interjected here. Many will be tempted to see a connection between the question of the predictability of the behavior of organic systems and those questions which have always exercised the human race, determinism and free will. It seems to me that there is no connection. The former is primarily a question of physical fact, while the latter are predominantly questions of a subjective character which involve those emotional experiences which the subject goes through when on the point of making a decision.

The concrete physical changes which are likely to arise from our modified attitude toward the causality principle are therefore small. I believe, however, that there will be very important effects on our methods and habits of thought and our entire outlook. One of the most obvious effects of these discoveries is in prescribing the program for future scientific investigation. One such possibility, I have just indicated, namely, the examination of the question as to whether the behavior of complex biological organisms is ever initiated by unpredictable small-scale events. A similar question arises with respect to other sorts of physical happenings; are there anywhere in nature mechanical systems of such a high degree of instability, as for example in the turbulent motion of a liquid, that an unpredictable small-scale event initiates a large-scale event, which thereby itself becomes unpredictable. Another possible program for future scientific investigation is in devising simple experiments which shall demonstrate less indirectly than we now can some of the statistical effects of small-scale events. For example, the invention of a photographic plate such that the impact of a single photon is sufficient to make a single grain of the plate developable would be an enormous assistance.

Apart from these concrete effects on our scientific program there will be many other less tangible results of our changed mental outlook, which I have not time to elaborate in detail here, but I shall try to give a few brief indications of what may be expected. A parallel may be drawn from the theory of relativity. Although the theory of relativity deals with phenomena which are so difficult to detect as to require instruments of the highest delicacy, nevertheless it has made exceedingly important changes in our attitude toward the fundamental concepts of space and time. I believe that in the same way the clear recognition that causality can not function in detail in small things, as has been supposed, but can have only a statistical meaning, must have important repercussions on our thinking. In fact, activity is already beginning in the ranks of the philosophers which bears out this contention. Many articles and even books have already appeared in which the endeavor is made either to explain away the importance of the new findings, or else to discover how we may adjust ourselves to them. The bearings on epistemology are apparently considered especially important. A single possibility may be mentioned. At a recent discussion between philosophers I heard it argued that the principle of sufficient reason is an absolute *sine qua non* of thought, that the human reason must by its very nature refuse to accept the possibility, to go back to the well-worn example of the billiard ball and the electron, that in one experiment the electron should appear at the seven-foot mark and in another at the five-foot mark, without there being some reason for the difference. To which I am afraid that the brutal physicist would be tempted to rejoin that if the human reason is incapable of accepting the situation, so much the worse for the human reason. However, these are questions of technical philosophy which are entirely beyond my sphere, and I shall not say anything more about them for fear of making even more egregious blunders than I may have already.

Apart from philosophical questions, however, it seems to me the realization that it is possible to exemplify on a large scale such things as our capriciously disintegrating radio-active material, which may serve as the nucleus of a superstitious religion, or may equally well serve as a most excellent gambling device, can not fail to get under the skin of the man in the street. This objectifies in the most striking way the limitations of the human intellect, and I believe that the greatest changes in our mental outlook will come as a consequence of the realization of just these human limitations—we had thought the human reason capable of conquering all things, we now find it subject to very definite limitations. We can definitely conjure up physical situations in which the human reason is powerless to satisfy itself, but must passively be content to accept phenomena as they occur, which constitutes in fact a reversion to the mental attitude of primitive man, which is purely receptive. What is more, the strictly scientific attitude recognizes no escape from the situation, but it must be accepted as inherent in the nature of things, and no way out attempted by such inventions, material or conceptual, as primitive man makes.

The realization of human mental limitations will, I believe, have the greatest effect, and the process of adjustment will be slowest, in such non-scientific activities as philosophy, religion, as already suggested, and very probably education, for some just apprehension of the possibilities of the human intellect should be imparted in any satisfactory educational program. The adjustment in scientific activity I believe will be made more rapidly, and in fact it is possible to see even now in what the adjustment will consist.

A formulation of the purpose of scientific activity which appeals to me as rather exhaustive is the understanding, prediction and control of events. It might be thought that the discovery that there are aspects of nature which are not understandable, predictable or controllable would work havoc with this scientific program. But the way out is already obvious. If it is true that there are certain aspects of nature which are neither controllable or predictable, then the obvious course is to avoid these aspects of nature. This may sound like a flippant suggestion, but the matter is really to a large extent in our own power. We have seen that although single small-scale events are unpredictable, the statistical average of large numbers of them is highly regular and predictable. The obvious course of action, then, whenever we want to be sure of the result, is to so arrange the apparatus or machine as to respond only to statistical averages, and not to function like a Geiger counter in response to single small-scale happenings. If it should prove that the large-scale behavior of biological organisms is unpredictable, then we shall take pains never to depend on the behavior of a single such organism whenever we have to be sure of our results, but this is hardly more than we do already.

The situation with regard to *understanding* small-scale events will probably take a little more adjustment, because it involves giving up an ideal which we had set ourselves. But even here the adjustment can hardly take more than one generation, and in science generations are short. Analysis will show, I believe, that what we call understanding consists in picking out from a situation elements with which we are already familiar. The difficulty in the present situation is that we are not familiar with systems in which individual events occur with no close connection with past events, so that naturally we are confused and seek for a hidden connection. But as our familiarity increases and the strangeness gradually wears off, we shall come to feel that it is natural and proper that small-scale events show only statistical regularities, and we shall come to be satisfied with our understanding of a situation when we have analyzed it sufficiently to show, if we are dealing with large numbers, the statistical regularities to be expected, or, if we are dealing with small numbers, the corresponding capricious variations. In fact, a number of the younger generation have already achieved this degree of emancipation, and the rest of us, by deliberate effort, may hope to attain it.

PALEONTOLOGY VERSUS DEVRIESIANISM AND GENETICS IN THE FACTORS OF THE EVOLUTION PROBLEM[1]

By Dr. HENRY FAIRFIELD OSBORN
AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY

This is a study in what may be called *progressive or adaptive heredity;* it is the second of a series of communications I plan to give to the National Academy on the factors of evolution; as implied in the title, this study is directly opposed to all accidental, discontinuous or mutational hypotheses of the causes of the bio-mechanical evolution of the germ plasm.

Last year I summarized results obtained through

[1] Address before the National Academy of Sciences, Washington, April 28, 1931.

twenty years of research on the evolution of the Titanotheres, a family which evolved during an estimated period of twelve million years, from an animal about a foot in height to the gigantic "thunder-beast" or Brontothere stage. This year I add results obtained from twenty-one years of research on the evolution of the Proboscideans, namely, the mastodonts and elephants, an order which may be traced over twenty million years, from present estimates of Tertiary time, beginning with animals about two feet in height and rising to animals over thirteen feet in height.

Dynamically the Proboscideans are very strong where the Titanotheres are weak, namely, in the evolution of the grinding teeth and of the pair of superior incisive tusks around which the entire life history of these animals centers.

As previously pointed out we can not comprehend the hereditary germ plasm without intensive research on the bio-mechanical evolution of form concurrent with research and experiment in biophysics and biochemistry. Bio-mechanical adaptation has this advantage, that it can be weighed and measured in fossil bones and teeth over periods of millions of years. We can also clearly distinguish between organs and organisms which are *static* and those which are *dynamic* or in the state of movement. One part of an organ may be in rapid evolution while a contiguous part may be standing absolutely still, as brilliantly illustrated in the discovery of the shovel-tusker mastodonts in Central Asia and in Nebraska. The detection of these relatively static or dynamic conditions, of arrest or of motion, of acceleration or retardation, is denied to all biophysical and biochemical experimentalists working on living organisms. For example, the fruit fly, *Drosophila*, is probably a completely static organism. The same we know to be true of members of the mouse family, which stopped evolving at least a million years ago; it is probably true of the guinea pig family.

Physical or chemical disturbance of the inconceivably delicate and minute hereditary mechanism produces anomalies and sports which may be hereditary but can not set in evolutionary motion either an organ or an organism.

So far as we can see in paleontology, continued hard work along the lines of maximum resistance is essential to setting an organ in evolutionary motion or acceleration. Parts of organs which do the hardest work evolve most rapidly, because the universal distinction of the bio-mechanism in contrast to the inorganic mechanism is that it develops both in the individual and in the race in the line of maximum resistance, for example, the upper and lower grinders of the elephant. Under this condition it is most dynamic; it becomes static when the resistance diminishes; it retrogresses when the resistance disappears.

This contrast between static and dynamic organisms and organs extends even into the most minute subdivisions of organs as in the microscope composition of the enamel of the gigantic tusks and grinding teeth of the Proboscideans, all the rest of the animal (excepting the proboscis) remaining *static*. The most refined analysis of the tusk enamel by polarized light reveals this universal principle of adaptive reaction to lines of maximum resistance.

The modes of bio-mechanical evolution were first perceived by the Greek anatomists who discovered seven principles. Shortly before the time of Darwin two more principles were added through researches in embryology; altogether nine bio-mechanical principles were known to Charles Darwin. A summary of the fourteen factors at present known is as follows:

BIO-MECHANICAL PRINCIPLES

Known to Lamarck, Darwin and Spencer

A. *Discovered through Human and Comparative Anatomy, Palaeomorphs*

1. Bio-mechanical progression, hypertrophy
2. Bio-mechanical retrogression, atrophy
3. Bio-mechanical compensation, metatrophy
4. Bio-mechanical economy, eutrophy
5. Bio-mechanical change of proportion, allometry, metatrophy
6. Bio-mechanical co-adaptation, coordination, correlation, through interaction
7. Bio-mechanical auto-adaptation, through principles 1–6.

B. *Discovered through Embryology*

8. Bio-mechanical acceleration of organs into earlier growth stages
9. Bio-mechanical retardation of organs into later growth stages

Unknown to Lamarck, Darwin and Spencer

C. *Discovered through Paleontology, Neomorphs*

10. Bio-mechanical germinal rectigradation, in the origin of new structures and organs
11. Bio-mechanical germinal pre-determination, in the origin of new structures and organs
12. Bio-mechanical phylogenetic acceleration, in the evolution of new structures and organs
13. Bio-mechanical phylogenetic retardation, in the evolution of new structures and organs
14. Bio-mechanical germinal potentiality, in the origin of new structures and organs

The remaining five bio-mechanical principles have been discovered through paleontology since Darwin's time. Neither Darwin nor Huxley had the least knowledge of the bio-mechanical factors of evolution as they have been revealed in paleontology.

CONCLUSIONS AS TO THE ORIGIN OF SPECIES

These fourteen bio-mechanical principles not only lend no support to the Darwin-DeVries hypothesis of mutation but are directly contrary to current assumptions and hypotheses by geneticists and experi-

mentalists that bio-mechanical adaptation can be induced by sudden changes in the genes. Whatever may be true of sudden bio-chemical adaptations a presumption from this overwhelming bio-mechanical evidence is that *both bio-chemical and bio-physical evolution is also along continuously adaptive and creative lines.*

William Bateson, founder of the genetic school, finally declared that genetics could not explain the origin of a single species. Modern paleontological research, on the other hand, reveals with absolute clearness and fullness not only how species originate bio-mechanically, but the inner interpretation of divergence in every grade of animal organization from the minute ascending mutations up to the higher points in the development of genera, families and orders.

The modes of these transmutations of form which from the same original materials produce the horse, the rhinoceros, the titanothere and the elephant are now absolutely clear, but the internal causes of these marvelous bio-mechanical transmutations of the germ plasm are far more mysterious and incomprehensible than they were in the time of Charles Darwin.

OBITUARY

ALBERT A. MICHELSON

AT one o'clock on Saturday afternoon, May 9, 1931, death came very quietly in his home in Pasadena to the most illustrious of the American physicists of our generation, at the age of seventy-eight years and five months. Six weeks earlier he had taken to his bed, after having made with his associates, Messrs. Pease and Pearson, enough observations to assure himself that his last experiment on the speed of light as measured in an evacuated pipe a mile long and three feet in diameter buried in the earth on the Irvine ranch near Santa Ana, California, was going to yield results as satisfactory as he had anticipated. This experiment had been planned for the sake of obtaining a check by a method entirely free from atmospheric effects of all kinds upon the accuracy of his next preceding determination made over a twenty-one mile stretch between California mountain peaks. He did not expect by these new experiments to exceed the accuracy previously obtained, but rather to add something to the *reliability* of the previous determination.

More than a month before his death, Mr. Michelson had known that he would never get up again, for a creeping paralysis was coming over him of which he himself was altogether conscious. His mind was quite clear until two days before the end, when a lesion occurred which brought on unconsciousness within an hour, an unconsciousness from which he never again awoke.

As one of the men who has had the most enduring and most intimate association with Mr. Michelson and his work, I esteem it a privilege to now make a few additions to my former appreciation of him and his achievement.

Under the caption, "Michelson's Economic Value," now published as Chapter VII in a volume by Scribner's entitled "Science and the New Civilization," I have attempted to appraise in broad lines the significance for our times of measurements of the highest skill and accuracy of the sort which Michelson has done and for which his name stands the world over, and I should like to refer to that appraisal and merely supplement it here by adding some details both of a scientific and of a personal sort.

Practically all Mr. Michelson's work in physics centered about determinations for increasing the precision of measurement. He has been called an extremely skilful and intelligent instrument designer, but while he was that he was much more than that, for his attention was always on the problem to be solved, not primarily on the instrument for solving it, and he was always seeking for problems incapable of solution save by improvements in the accuracy of measurement. Ten different times in the fifty-one years of his activity, extending from 1880, when at the age of twenty-eight he became the best known American physicist by virtue of his new speed-of-light measurement, up to 1931, when he died, still trying to prove the certainty of his determination and precision of that most fundamental constant, he made major outstanding advances, which I list as follows:

(1) Measurements of the speed of light, 1880–1931.

(2) Development of the Michelson interferometer, 1882, *et seq.*

(3) Ether-drift experiments, 1887–1928.

(4) The first analysis of the fine structure of spectral lines, 1894–1900.

(5) Development of the Michelson-Stratton harmonic analyzer, 1897.

(6) Development of the principle of the Echelon spectrograph, 1898.

(7) Perfection and increase in resolution of the line grating, 1902–1917.

(8) First accurate measurement of the rigidity of the earth, 1916.

(9) Development of the U. S. naval range finder, 1918.

(10) Direct interferometer measurement of the diameter of stars, 1921.

Of these ten, four—namely, the second, third, fourth and tenth—have to do primarily with the interferometer or its application to various sensitive measurements. It was in measurements relating to the interference of light and speed of light that he was by far the greatest expert that the world has yet seen. He spent his scientific life largely in these two fields. He was not an omnivorous reader of the literature of physics, and did not try to follow closely the developments of the theoretical fields of electronics and quantum theory. He was essentially a classical physicist, but any one who ever heard him conduct a Ph.D. examination in physics, and any one who ever attended his lectures or heard him speak knows that his grasp of classical physics was penetrating and precise. His lectures and his papers were masterpieces of elegance and conciseness. He used few words, but they were just the ones he wanted. Indeed, the precision of his mind was its dominating characteristic, which showed even in his sports. I have played tennis with him all my life, and his calling of balls, for example, was never generous either to himself or to his opponent. It was simply exact and just. Closely allied to this characteristic was his altogether extraordinary honesty. Pretense of any kind was utterly foreign to his make-up. Indeed, he was one of those very rare persons who would not even tolerate fooling himself with respect to his own motives, as so many of us do. If his conduct was ever ungenerous he knew it and frankly admitted it, whether he thought it wise to change it or not. Before I became intimately associated with him I had heard that he was considered by his pupils to be somewhat unapproachable, occasionally arbitrary, and at times dictatorial, if not unreasonable, but in the twenty-five years in which we worked together I could not have been treated with greater courtesy and consideration, even in the few cases in which we differed in judgment. His dignity and courtesy of bearing were altogether striking characteristics, and as the years passed he grew to be a man of great mellowness, kindness and affability.

Like many a scientist, Mr. Michelson was also an artist, with a keen feeling for form and color, as well as for music. He painted well, played the violin well, and did well at tennis, chess and billiards.

American science and the American nation have lost in his death one of their finest and greatest figures.

ROBERT A. MILLIKAN

MAY 11, 1931

VERANUS ALVA MOORE—PIERRE AUGUSTINE FISH

BOTH these men were natives of New York State—Dr. Moore, of the western border in the Lake Ontario basin, and Dr. Fish of the eastern portion in the Hudson River Valley. Both received their early education in the schools and academies of the state, and both were graduates of Cornell University.

Both were called as heads of departments in the original faculty of the New York State Veterinary College at Cornell, and finally both became deans of the college, Dr. Moore succeeding Dr. James Law in 1908, and Dr. Fish succeeding Dr. Moore in 1929. Their friendship, mutual help and confidence in each other continued without a break till the end of life. Both, as if of one spirit, served their country in the World War.

Veranus Alva Moore was born at Houndsfield, Jefferson County, New York, April 13, 1859, and died at Ithaca, New York, on February 11, 1931. His parents were Alva and Antoinette Eastman Moore.

The Moore family, as was common in pioneer days, had mainly the wealth of strong hands and independent character. The father died when the boy was but thirteen years old, thus compelling him to assume the duties of a man very early in life. Young Moore had the manly qualities, and went out to work on a farm to support himself and to help the mother and children. In this farm labor he had the misfortune to step on a nail, which penetrated his foot and set up an infection in the bones which caused him much suffering for the next ten years.

This accident compelled him to come in contact with physicians to obtain relief, and he finally became a patient in Bellevue Hospital, New York. There he saw hospital management and ate the hospital food of the time. He also saw and was operated upon by the famous surgeons of the period, and saw all too often the infections which followed operations. Knowledge of the rôle played by bacteria in infections was known and appreciated by very few, and the pioneer work of Lister in applying to surgery the knowledge of micro-organisms which Pasteur had made known was then not deemed worthy of serious consideration in the minds of most of the medical men.

This contact with physicians and hospitals was destined to have a great influence on Moore's life and to determine later its trend. Meanwhile he made great progress in fundamental education, taught district school, and made a success of it in spite of the crutches he had to use. Never satisfied with present attainments, he passed from the district schools to Mexico Academy, in Oswego County. There he came under the stimulating influence of one of the fine principals (James Gifford) found everywhere as heads in the academies (really junior colleges) of those days. He graduated from the academy in the spring of 1883, and in the fall of that year entered Cornell University, and graduated with his class in 1887.

In the spring of 1887 he had completed the required work for graduation, and was recommended and accepted as assistant with Drs. D. E. Salmon and Theobald Smith in the U. S. Bureau of Animal Industry at Washington.

At this time epoch-making changes were taking place. Meat inspection was being introduced at the great abattoirs, researches were going on to determine the cause and prevention of hog cholera and the Texas fever of cattle. He remained in the bureau for nine years, advancing step by step, until in 1895, when Dr. Theobald Smith went to Harvard, Dr. Moore was made chief of the division of animal pathology. This Washington experience gave him an intimate knowledge of the problems confronting the live-stock interests of the whole country. It also brought him in contact with the leading men of the country both in human and in veterinary medicine.

On the establishment of the New York State Veterinary College in 1896, Dr. Moore was invited to the chair of bacteriology, pathology and meat inspection. Here was carried on the main part of his life work. With his broad experience in the government service, and under the influence of the high ideals of Dr. Law, dean of the college, Dr. Moore entered enthusiastically into the building up of this enterprise. There appeared before him two great goals to attain: To make the preliminary education of students more adequate, and to so teach and train the men in his subjects that they would be on a par with the men in the great profession of human medicine. He knew also the need for and the desire for knowledge of the laws of health, and the ways to avoid such infections as he had suffered from, by the public in general. He therefore gave not only to his students, but in public addresses, in written articles and in his books the information needed by students, the veterinary profession, the stock owners of the country and the general public.

In his thirty-three years of service, he saw the preliminary educational requirements advanced to a full high-school course, and the professional training to four years, as with human medicine. Twenty-one of these thirty-three years of service, he was dean of the college and therefore in a position to bring about more effectively the changes and advances which he saw were needed. He saw the college grow both in students and faculty, and also in financial support. Besides being a great administrator he was a great teacher, and when the alumni went forth into the world, he still had a great interest in them and sent a Christmas letter to each one. In this letter were notes concerning the university as a whole, and of the college in particular, also notes concerning the faculty and the alumni. The alumni were made to feel that the college was to them a real *alma mater*, and welcomed them whenever they returned.

One of the last services which Dean Moore rendered the college was a 47-page pamphlet giving the history of the veterinary work of the university from its beginning, with Dr. James Law as its exponent, until his own retirement in 1929. This history fills one with renewed courage, for it shows how intelligence and devoted service can make advances.

On retiring from the Veterinary College at the age of seventy, Dr. Moore had planned to devote his remaining years to a quiet life of research, and especially to the preparation of a history of veterinary medicine in America. But that was not to be.

From his twelve years on the Ithaca Board of Health, twelve years on the school board, and as trustee of the Ithaca Memorial Hospital and on its medical staff for a long period, he seemed by this training, and his knowledge of the best practice in present-day hospitals, and also the defects of early-day hospitals, and his tried administrative skill, to be just the right person to straighten out the difficulties into which the hospital had become involved with its ever-growing financial deficit and the lack of team work in the staff. Here was a call for help, and to help had been his greatest aim in life. So he put aside the plans for repose and became head of the hospital. Besides his knowledge, he brought to this task that precious faith in human nature which makes all roads straight, and commands everywhere loyalty and devotion to ideals.

All his constructive work and plans were making notable progress when he himself came to need the ministrations of the hospital. There on the morning of February 11, 1931, he passed from the sleep in life to the final sleep in death.

Dr. Moore had a most hospitable home. There were two sons and a daughter, and there came also grandchildren to bring happiness in his advancing years.

In the community, and among the students, the faculty, his scientific and professional friends he was regarded with both respect and affection.

Pierre Augustine Fish was born at Chatham, Columbia County, N. Y., February 17, 1865, and died at his home in Ithaca, New York, on February 19, 1931. His parents were Irvin A. and Margaret Shufelt Fish.

The father was a furniture dealer in the village, and the young man aided in the care of the store when not in school. Besides the village schools he attended the South Berkshire Institute, New Marlboro, Massachusetts, and Hartwick Seminary, near Cooperstown, New York. He entered Cornell University and

graduated with the degree of B.S. in natural history in 1890, and doctor of science in 1894. From 1890 to 1895 he was instructor in vertebrate zoology and neurology in Cornell, and during the summer, from 1891 to 1895, he was instructor in the Woods Hole Marine Biological Laboratory.

Under the inspiring influence of Burt G. Wilder, he became greatly interested in the central nervous system, and fifteen of his earlier papers were upon that subject. His three-dimensional models of small brains, made easily possible by the Born wax-plate reconstruction method, were the first to be made in Cornell. He also applied the Golgi-Cajal silver staining method for elucidating the fine structure, and was very successful with both methods, as may be seen by consulting his paper on the small salamander, Desmognathus, in Vol. X (1895) of the *Journal of Morphology.*

In 1895 Dr. Fish had the opportunity of joining the staff of the Bureau of Animal Industry, and in that year had impressed upon him the tremendous problems involved in the animal husbandry of the country.

On the opening of the Veterinary College at Cornell University in 1896, he, like Dr. Moore, was called as a member of the original faculty. His department was physiology and pharmacology. He threw himself heart and soul into the work. He found the students sadly lacking in preliminary education, and from the beginning worked with Dr. Law and the rest of his colleagues to increase the entrance educational standard, so that the lecture and laboratory work in his subjects might be understood and made so thorough that the alumni would be ready to meet the actual experiences of life in practice with credit to themselves. During the thirty-five years of service to the college he gave class-room instruction to every student who graduated. No one can overestimate the influence of such a teacher upon the minds of these young people whose habits of thinking and study were being formed. He planted in those receptive minds a sense of responsibility, and seriousness, and an appreciation of the sciences on which their life work was based. It was well expressed by one who has since gained distinction: "I look back with gratitude to Dr. Fish for the insight he gave me into the dignity of science, and the way scientific knowledge is gained." Dr. Fish had also great influence for good to the students in his service as secretary of the faculty for twenty-nine years.

He was editor of *The Cornell Veterinarian* for its first five volumes, 1911 to 1916, and of the *Journal* of the American Veterinary-Medical Association from 1915 to 1918. In this editorial field he was especially effective; with a fine literary sense, he put in cogent form the needs and opportunities of the veterinary profession. In his discussions there was fairness and tolerance, but still an insistence on the highest ethical standards.

Dr. Fish was a fellow of the American Association for the Advancement of Science, and of course of the State and National Veterinary Societies.

His numerous writings, including several books, pertain mostly to the physiology of the domestic animals and their relation to human beings. Some of these striking papers deal with veterinary education, and the need of a general fundamental education before entering upon the professional studies.

The keenness of his mind and his comprehension of the requirements for true scientific investigation was impressed on the writer during a joint research extending over three years after he left the U. S. Army service at the end of the world war. Dr. Fish exemplified the ideal researcher. To find the truth was the goal, and no labor was too great to attain that end. He spurned the easy way to cover up ignorance by plausible guesses.

In 1929 when Dr. Moore retired at the age of seventy, he was chosen by the university administration to become dean of the Veterinary College. Dr. Fish was perfectly familiar with the administrative details of the college and shared the ideals of his predecessors; naturally, therefore, it continued its forward march under his wise and considerate leadership.

The students, the faculty and the alumni gave most loyal support, and Dr. Moore in public addresses and in private used his large influence most generously in support of his successor.

A severe cold contracted on a journey to and from Schenectady to give a broadcast on the rise and progress of the veterinary profession in America finally terminated in pneumonia and ended his life, February 19, 1931, eight days after his predecessor and friend, Dr. Moore, had passed away.

Dr. Fish preferred the quiet life of teaching and research to more public activities, but when public duties confronted him he accepted them, and carried them through so finely that every one approved and was satisfied. He was greatly sought for as toastmaster. Every one felt confident that if he presided there would not be a dull moment in the program. His own elegant and witty expressions set the pace and kept the events moving without a hitch.

Dr. Fish's home, with his five children, four daughters and a son, offered a warm welcome to students, colleagues and friends. He was a good neighbor, a good citizen, not only of his own community but of the whole state and nation, and was trusted and honored by all.

The writer would like to express gratitude for the

privilege of teaching these men, for seeing them develop and become beneficent forces in the progress of our country, for having them as colleagues in university work and for their lasting friendship. It was hoped that they might say a kindly word for their old teacher instead of the duty falling upon him to speak for them.

SIMON HENRY GAGE

MEMORIALS

MEMORIAL services for Professor Albert A. Michelson were held on the afternoon of May 18 in Joseph Bond Memorial Chapel of the University of Chicago. Dr. Max Mason, president of the Rockefeller Foundation, spoke on "Professor Michelson as a Scientist." Dr. Mason was for five years president of the University of Chicago, and was previously professor of mathematical physics at the University of Wisconsin. Dr. Henry Gordon Gale, dean of the physical sciences division, who collaborated with Professor Michelson in the study of earth tides, spoke on "Professor Michelson as a man." Dr. Robert Maynard Hutchins, president of the university, spoke on "Professor Michelson's Service to the University of Chicago."

BRONZE busts of four Americans were unveiled on May 14 at the Hall of Fame of New York University: James Monroe, fifth president; Matthew Fontaine Maury, oceanographer; Walt Whitman, poet, and James Abbott McNeill Whistler, artist. The bust of Maury is the work of F. William Sievers, of Richmond, Va., who made the Maury monument in that city. The gift of the United States Daughters of the Confederacy, it was unveiled by Matthew Fontaine Maury, 3rd, great-grandson. Professor S. A. Mitchell, director of the Leander McCormick Observatory of the University of Virginia, and Rear Admiral Walter R. Gherardi, hydrographer of the Bureau of Navigation, spoke in tribute to Maury.

RECENT DEATHS

DR. SAMUEL WILSON PARR, professor emeritus of practical chemistry in the University of Illinois, died on May 16. He was seventy-four years old.

DR. HENRY J. PRENTISS, head of the department of anatomy in the University of Iowa, died on May 17, aged sixty-three years.

Nature announces the following deaths: Dr. J. Anderson, formerly fellow of the London School of Tropical Medicine, later professor of medicine in the University of Hong-kong and recently director of the division of medicine in the Henry Lister Institute at Shanghai, aged fifty-two years; of Professor R. K. Butchart, professor of mathematics in Raffles College, Singapore, and formerly professor of physics in Wilson College, Bombay, on March 30. Senator R. Nasini, professor of chemistry in the University of Pisa, on March 29, aged seventy-five years. Professor Hugh Ryan, professor of chemistry in the University College of Dublin and chief state chemist to the Irish Free State, on March 27, aged fifty-seven years. Mr. T. C. Cantrill, formerly of the Geological Survey of Great Britain, on April 3, aged sixty-three years, and of Sir John de Villiers, noted especially for his work while in charge of the map room at the British Museum and his contributions to geographical and historical literature, on April 2, aged sixty-seven years.

SCIENTIFIC EVENTS

THE LAKESIDE HOSPITAL IN CLEVELAND

THE dedication of the new Lakeside Hospital of the medical center of Western University will take place on June 17. The hospital completes the development of the medical school at the university, which has been made possible by gifts amounting in all to $15,000,000. The buildings include the Schools of Medicine, Nursing, Pharmacy and Dentistry; the Institute of Pathology, Babies and Children, Maternity and Rainbow Hospitals; the Medical Library, the Nurses' Dormitory and the Robb and the Hanna Houses, the latter a private patients' pavilion.

Dr. Hans Zinsser, professor of bacteriology at Harvard University, will make the principal address at the dedication ceremonies. Mr. Samuel Mather, president of Lakeside Hospital for more than thirty years, will preside. Mr. Mather built the School of Medicine and has been the largest single contributor in the development known to the public as the "Cleveland Medical Center." President Robert E. Vinson, of Western Reserve University, will confer honorary degrees.

The dedication will take place in the morning and will be followed by a luncheon under the auspices of the Lakeside Alumni Association in Robb House. In the afternoon are scheduled a scientific session, an inspection of Lakeside Hospital and a visit to the Institute of Pathology. The evening will be occupied with the dinner of the Lakeside Alumni Association.

THE NEW ORLEANS CHAPTER OF THE PAN AMERICAN MEDICAL ASSOCIATION

AT the call of Dr. Arthur Vidrine and Dr. Rigney D'Aunoy, a number of prominent New Orleans physicians met recently in the library of the Charity

Hospital for the purpose of organizing a chapter of the Pan American Medical Association.

The Pan American Medical Association, established ten years ago, has for its objects the promotion of intimate relations, scientific and otherwise, between physicians and surgeons of the western hemisphere, with the idea of advancing medical knowledge and interchanging professors of various medical subjects between different seats of learning, and the development of inter-American scientific literature by means of official publications and an international lending library.

Chapters of the organization exist at present in New York City; Rochester, Minnesota; Baltimore; Atlanta; Miami; Chicago; Detroit; Havana, Cuba; Matanzas, Cuba; Santiago, Cuba; Panama; Merida, Mexico; Mexico City; San José, Costa Rica; Caracas, Venezuela; Sao Paulo, Brazil; Buenos Aires, Argentina, and Bogota, Colombia.

At the organization of the New Orleans chapter the following officers were elected:

President: Dr. Aristides Agramonte.
Vice-President: Dr. P. F. Murphy.
Secretary: Dr. Rigney D'Aunoy.
Treasurer: Dr. Gilbert Anderson.

It was unanimously voted to invite the association to hold its 1932 congress in the City of New Orleans, and Dr. Aristides Agramonte was elected a delegate to the congress to be held in Mexico City from July 12 to 16, 1931, with instructions to extend such an invitation.

THE KENTUCKY ACADEMY OF SCIENCE

THE eighteenth annual meeting of the Kentucky Academy of Science was held on May 2 at Transylvania College, Lexington, Kentucky. The meeting was well attended and much interest shown, thirty-five papers being given in the three divisions. The presidential address, by Dr. V. F. Payne, was entitled "A Chemist Views the Social Sciences." The guest-speaker of the afternoon, Dr. Edmund M. Baehr, of the University of Cincinnati Medical College, spoke on "The Uses of Adversity."

Committees were appointed to consider the matter of junior societies affiliating with the academy; to suggest scientific books to be placed in certain libraries; and to select a suitable place for an academy library.

The following officers were elected:

President: Dr. Anna A. Schnieb, Eastern State Teachers College, Richmond, Ky.

Vice-president: Dr. Charles Hire, Murray State Teachers College, Murray, Ky.

Secretary: Dr. A. M. Peter, Experiment Station, Lexington, Ky.

Treasurer: Prof. W. S. Anderson, Experiment Station, Lexington, Ky.

Council for the American Association for the Advancement of Science: Dr. Austin R. Middleton, University of Louisville, Louisville, Ky.

The academy has now 195 members—the largest membership since its organization. The publication of its *Transactions* has been brought up to date in Volumes 1, 2, 3 and 4.

At the close of the meeting the old Medical Library of Transylvania College was open for inspection. This library contains many rare old books, being the first medical library west of the Allegheny Mountains.

A. M. PETER,
Secretary

THE KANSAS ACADEMY OF SCIENCE

THE sixty-third annual meeting of the Kansas Academy of Science was held at the University of Kansas at Lawrence, on April 24 and 25. General papers and business occupied the forenoons. Over 120 papers were listed, about three fourths of which were given on the afternoon of April 24 in the meetings of the sections of biology, chemistry, physics, psychology and junior academy. The section of entomology met on the afternoon of April 25.

The address by the retiring-president, Dr. Hazel E. Branch, of Wichita University, was given on the evening of April 24, at the banquet. Her subject was "Aims and Opportunities of a Junior Academy of Science in Kansas." The principal address of the session was given later in the evening by Dr. Geo. K. Burgess on the work of the U. S. Bureau of Standards. This was given under the auspices of the University of Kansas Chapter of Sigma Xi.

A Section of Physics and a Junior Academy of Science were organized this year for the first time. Of the few remaining complete sets of the *Transactions* a number were sold to members of the academy in accordance with the policy of the academy not to maintain a library of its own. Last year the exchange rights of the academy were divided between the University of Kansas, the State College and the Fort Hays College, which institutions aid in the publication of the *Transactions*.

The following officers were elected for the ensuing year: *President*, Roger C. Smith, Manhattan; *first vice-president*, Wm. J. Baumgartner, Lawrence; *second vice-president*, J. Willard Hershey, McPherson; *secretary*, George E. Johnson, Manhattan; *treasurer*, Ray Q. Brewster, Lawrence. The new chairmen of the sections are: Biology, Wm. J. Baumgartner, Lawrence; Chemistry, Walter S. Long, Salina; Entomology, Raymond H. Beamer, Lawrence; Physics, E.

V. Floyd, Manhattan; Psychology, Raymond H. Wheeler, Lawrence; Junior Academy, Hazel E. Branch, Wichita. *Additional members of the executive council are*: Hazel E. Branch; Robert Taft, Lawrence, and J. A. G. Shirk, Pittsburg.

The Kansas Academy at the date of the annual meeting had an active membership of over 300, of which 13 are honorary and 51 are life members.

The meeting in 1932 will be held at McPherson.

George E. Johnson,
Secretary

THE MEDAL MEETING OF THE FRANKLIN INSTITUTE

The Medal Meeting of the Franklin Institute, Philadelphia, was held on the afternoon of May 20. The Franklin Medallists, Dr. Willis R. Whitney and Sir James Hopwood Jeans, were the speakers. Dr. Whitney's address was entitled "Research: Theory and Practice," and Sir James's "The Origin of the Solar System."

Other medals were presented as follows:

Longstreth Medal to Charles G. Garrard, M.E., Thorn, England.

Wetherill Medals to Thomas Tarvin Gray, president Gray Industrial Laboratories, Newark, New Jersey; Arthur J. Mason, Homewood, Illinois; Henry M. Sutton, Edwin G. Steele and Walter L. Steele, Sutton, Steele and Steele, Inc., Dallas, Texas; Edward C. Wente, Ph.D., Bell Telephone Laboratories, Inc., New York City.

Levy Medal to J. Stuart Foster, Ph.D., assistant professor of physics, McGill University.

Henderson Medal to Arthur Newell Talbot, Sc.D., D. Eng., professor of engineering, emeritus, University of Illinois.

Clark Medal to Daniel J. Young, consulting engineer, Tacoma, Washington.

Potts Medal to Benno Strauss, Ph.D., Essen, Germany.

Cresson Medals to Clinton J. Davisson, Ph.D., and Lester H. Germer, Ph.D., Bell Telephone Laboratories, Inc., New York City; Kotaro Honda, director, Research Institute for Iron, Steel and Other Metals, Tohoku Imperial University, Sendai, Japan, represented by the Honorable K. Midzusawa, first secretary of the Japanese Embassy, Washington, D. C.; Theodore Lyman, Ph.D., director emeritus, Jefferson Physical Laboratory, Harvard University, Cambridge, Massachusetts.

SCIENTIFIC NOTES AND NEWS

Resolutions were adopted by the Michigan legislature on April 14 citing the accomplishments and contributions to medicine and chemistry of Dr. Frederick G. Novy, professor of bacteriology, University of Michigan Medical School; of Dr. Moses Gomberg, professor of chemistry, University of Michigan, and of Dr. Reuben L. Kahn, of the Michigan State Department of Health. The ceremony was attended by Governor Wilber M. Brucker, Mr. Henry Ford, the supreme court justices, other state officials and many physicians. Governor Brucker, in opening the program, stated that the plan had been originated by Dr. James T. Upjohn, senator from Kalamazoo and chairman of the senate public health committee.

On the occasion of the presentation on May 22 of the Willard Gibbs Medal to Dr. Phoebus A. Levene, of the Rockefeller Institute for Medical Research, a banquet was held at the Steuben Club, Chicago. Dr. Hermann I. Schlesinger, University of Chicago, chairman of the Chicago section of the American Chemical Society, presided. Dr. Fred G. Koch, University of Chicago, presented the medal, after which Dr. Levene delivered an address on "The Revolt of the Biochemists." Responses were made by Dr. Lawrence V. Redman, president-elect of the society, and by Dr. Robert M. Hutchins, president of the University of Chicago. The Willard Gibbs jurors, forming the committee of award, are: B. S. Hopkins, W. Lee Lewis, S. C. Lind, Julius Stieglitz, W. D. Bancroft, G. Borrowman, Otto Folin, F. C. Whitmore, W. L. Evans, A. A. Noyes, L. V. Redman, Harry Steenbock and H. I. Schlesinger, chairman.

Sir James Hopwood Jeans received the honorary degree of doctor of laws from the Johns Hopkins University on May 15. He was presented by Dr. Robert W. Wood, professor of experimental physics, and the degree was conferred by President J. S. Ames. A dinner in honor of Sir James will be given at the Hotel Astor, New York, on Thursday, May 28, under the auspices of the New York Museum of Science and Industry, the American Institute, the American Museum of Natural History, the Amateur Astronomers Association, the New York Academy of Sciences and the *Scientific Monthly*. Professor Michael I. Pupin will preside and will introduce the speaker. Reservations may be obtained from the New York Museum of Science and Industry, 220 East 42nd Street, New York City.

Dr. Karl Ferdinand Herzfeld, professor of physics at the Johns Hopkins University, has been designated as the recipient of the Mendel Medal, awarded annually to a Roman Catholic who has achieved distinction in the field of science. The previous winners of the Mendel Medal, which was founded three years ago, are Dr. John A. Kolmer, of the University of Pennsylvania, and Dr. Albert

F. Zahm, chief of the division of aeronautics in the Library of Congress.

THE Oberly Memorial Prize, founded in honor of Eunice Rockwood Oberly, librarian of the Bureau of Plant Industry, who died in 1921, has been awarded to Mr. Everett E. Edwards, economist of the U. S. Department of Agriculture, for his publication entitled "A Bibliography of the History of Agriculture in the United States."

THE British Iron and Steel Institute has awarded the Carnegie Gold Medal for engineering research to Dr. E. Valenta, of the Skoda Works, Pilsen. The work for which the medal was awarded is a book entitled "Heat and Acid-resisting Cast Iron with High Chromium and Carbon Content," and represents the results of two years' experiments. It was issued by the Carnegie Fund as part of the series, Carnegie Memoirs, in connection with the Iron and Steel Institute.

IT is stated in *Nature* that the following have been proposed for election as honorary members of the German Chemical Society: A. Angeli (Florence), E. J. Cohen (Utrecht), W. Ipatiew (Leningrad), Irving Langmuir (Schenectady), H. Le Chatelier (Paris), Sir William Pope (Cambridge), Th. Svedberg (Upsala), and E. Warburg (Berlin).

THE council of the Royal Geographical Society has made the following awards for 1931: The Murchison Grant to Mr. L. M. Nesbitt, for his journey through the Danakil country of Abyssinia; the Back Grant to Col. R. H. Rowe, for his surveys in Nigeria and on the Gold Coast; the Cuthbert Peek Grant to Mr. H. J. L. Beadnell, for his explorations in the Libyan Desert; the Gill Memorial to Mr. Michael Spender, for his studies of the Great Barrier Reef.

THE following elections were made at a meeting of the executive committee of the American section of the Society of Chemical Industry on May 8: *Chairman,* Allen Rogers; *Treasurer,* F. C. R. Hemingway; *Secretary,* Foster D. Snell; *New Members of the Executive Committee,* William Gesell, Robert J. Moore, Arthur Singmaster, Irving Hochstadter and Benjamin T. Brooks.

PROFESSOR HAROLD L. ALLING, of the University of Rochester, was elected president of the New York State Geological Association at the meeting held at Port Henry on May 16. Professor Edward Hoffmeister, also of the University of Rochester, was elected secretary.

OFFICERS of the Physical Society, London, have been elected as follows: *President:* Sir Arthur Eddington; *Secretaries:* Dr. Ezer Griffiths and Dr. Allan Ferguson; *Foreign Secretary:* Professor O. W. Richardson; *Treasurer:* Mr. R. S. Whipple; *Librarian:* Mr. J. H. Brinkworth; *Assistant Secretary:* Dr. J. J. Hedges; *Editor:* Captain C. W. Hume.

DR. FRANK R. LILLIE has been elected dean of the division of biological sciences of the University of Chicago, succeeding Dr. Richard E. Scammon, who is returning to the University of Minnesota to become dean of the medical sciences there.

DR. W. F. HAMILTON has been appointed full professor of physiology at the University of Louisville.

DR. PAUL A. MOODY has been promoted from assistant professor of zoology in the University of Vermont to an associate professorship, and Lyman S. Rowell has been advanced from instructor to the rank of assistant professor of zoology.

Nature reports that at the end of last year, Professor A. A. Ivanoff retired from the position of director of the Observatory in Pulkovo and took over the office of the president-adjoint of the Central Chamber of Weights and Measures, Leningrad.

DR. JAMES H. MEANS, Jackson professor of clinical medicine at the Harvard Medical School, was recently elected a member of the board of regents of the American College of Physicians.

DR. LEWELLYS F. BARKER, of Baltimore, served at the Peter Bent Brigham Hospital, Boston, as annual physician-in-chief, *pro-tempore,* for the week begining on April 20.

THE J. T. Baker Chemical Company's Analytical Fellowship, Eastern Division, has been awarded to Nelson Allen for the academic year 1931–1932, to work at Princeton University. Mr. Allen received the B.S. degree from Centre College, Kentucky, in 1927, and the M.S. degree from the University of Chicago in 1927, and is now assistant professor at Centre College.

THE Committee on Scientific Research of the American Medical Association has granted $500 to Drs. Harold G. Grayzel, Maxwell Bogin, Hyman Warshall and Mendel Jacobi for continuation of their studies in amyloidosis. The investigations are conducted at the Pediatric Research Laboratory of the Jewish Hospital of Brooklyn.

THE Scientific Club of Winnipeg has awarded its Research Prize of $250, for the most meritorious investigations conducted by a post-graduate student in the University of Manitoba during the last three years, to P. A. Macdonald, Ph.D. The researches of Dr. Macdonald, which were carried out in the department of physics, consisted of studies of the senses of temperature, pain, vision, touch and hearing, with particular reference, in the last three, to the validity of the Weber-Fechner law.

PROFESSOR WILLEM DE SITTER, of the University of Leyden, will visit Mount Wilson Observatory next winter.

SIR FREDERICK WILLIAM ANDREWES, professor of bacteriology at the University of London, recently visited the University of Wisconsin to make observations of work on agglutination problems in progress at the College of Agriculture in the departments of veterinary science and bacteriology.

H. H. WHETZEL, professor of plant pathology at Cornell University, represented the university at the inauguration of the chancellor of the University of Porto Rico on May 20. The new chancellor is Carlos E. Chardon, formerly commissioner of agriculture and labor in the Governor's Cabinet. Professor Whetzel will also give the commencement address at the College of Agriculture at Mayaguez, Porto Rico, on May 25.

DR. NILS A. OLSEN, chief of the Bureau of Agricultural Economics, has been selected by Secretary Hyde to represent the U. S. Department of Agriculture at the conference of wheat-exporting countries, which opened on May 18 at Canada House, London. The Federal Farm Board sent Mr. Sam R. McKelvie as its representative. Dr. Alonzo E. Taylor, of the Food Research Institute of Stanford University, accompanied Mr. McKelvie as technical adviser.

DR. ALBERT W. HERRE, curator of the Zoological Museum of Stanford University, is making preparations for an extensive trip through the Sulu Archipelago, British North Borneo, and parts of the island of Mindanao of the Philippine group, during next year, which will be his regular sabbatical leave. During his trip Dr. Herre expects to gather new fish specimens for the museum at Stanford and to add to scientific knowledge concerning the territory he is to visit.

THERE will be a general assembly of the International Scientific Radio Union in Copenhagen from May 28 to June 8. The following delegates will represent the United States: Messrs. Austin, Briggs, Chaffee, Dellinger, Squier and Wilson. The meeting is being held at the same time and place as the meeting of the official body known as the Technical Consulting Committee on Radio Communication.

SIR JAMES JEANS will deliver the first annual public lecture of the Harvard chapter of Sigma Xi, in Sanders Theater at 8.15 p. m., on May 26, on "The Annihilation of Matter." The lecture is made possible through the courtesy of the Franklin Institute, of Philadelphia, of which Sir James is Franklin medalist for this year.

ON April 17, Dr. R. G. Aitken, director of Lick Observatory, addressed the University of Cincinnati chapter of Sigma Xi at the annual initiation meeting. His subject was "Our Changing Universe."

DR. E. D. MERRILL, director-in-chief of the New York Botanical Garden, delivered an illustrated address on May 21 before the Washington Academy of Sciences on "Plants and Animals of the Philippines and Neighboring Islands—How They Came to be Where They Are."

DR. ROBERT A. MILLIKAN, of the California Institute of Technology, delivered two general university lectures at the University of Oklahoma on May 3 and 4. His subjects were "Science and Religion" and "Opportunities in Science." At a breakfast given in his honor, he addressed members of the physics department and guests on "Recent Developments in the Study of Cosmic Rays."

DR. ARTHUR H. COMPTON, of the University of Chicago, was the chapel speaker at Pennsylvania College for Women, Pittsburgh, on May 8. His subject was "The Human Side of Science."

DR. CLARENCE COOK LITTLE, director of the Roscoe B. Jackson Memorial Laboratory, at Bar Harbor, Maine, formerly president of the Universities of Maine and Michigan, will be the chief speaker at the University of Maine alumni banquet to be held during commencement week on June 6, at which time President Harold S. Boardman will act as toastmaster.

MRS. MAYME I. LOGSDON, associate professor of mathematics at the University of Chicago, was the principal speaker at the annual meeting of the Kentucky Section of the American Mathematical Association held at the University of Kentucky on May 9.

DR. ARNO B. LUCKHARDT, professor of physiology at the University of Chicago, delivered on May 7 and 8 two lectures under the auspices of the Gorgas Medical Society at the School of Medicine of the University of Alabama. The subjects were "The Parathyroid Glands, their Pathology and Physiology" and "High Lights and Shadows in the History of the Discovery of General Anesthesia." After the close of the second lecture Dr. Luckhardt was made an honorary fellow in the Gorgas Medical Society.

ON April 30 and May 1 Dr. Joseph H. Bodine, professor of zoology in the University of Iowa, lectured at the University of Michigan under the auspices of the department of zoology, on the following subjects: "Some Fundamental Problems in the Physiology of Development," "Respiratory

Metabolism of a Developing Egg" and "Cycles or Rhythm in Development." Dr. Fernandus Payne, professor of zoology at the University of Indiana, lectured on May 7 and 8 on "Twentieth Century Advances in Biology," "A General Discussion of Protoplasmic Structure and in particular the Cytoplasmic Structures" and "The Cytoplasmic Structures in Developing Insect Eggs."

AN intersectional meeting of the American Chemical Society is to be held at Pasadena, California, from June 15 to 20, in conjunction with the national meeting of the American Association for the Advancement of Science. This is an unusually important scientific event, which a number of distinguished eastern and foreign speakers will attend. Members of the American Chemical Society are invited to present papers at the sessions held during the latter part of the week. Morning sessions during the earlier days of the meeting will be devoted to symposia.

FOR the first time since 1897 the American Medical Association will meet this year in Philadelphia, the city in which it was founded eighty-four years ago. The new municipal auditorium will be the focal point of the meeting, which will be held from June 8 to 12. With the exception of the meetings of the House of Delegates, all meetings and exhibits will be held there and in the adjoining commercial museum.

THE South Dakota Academy of Science held its sixteenth annual meeting at Eastern State Teachers' College, Madison, South Dakota, on May 8 and 9. Twenty-four papers were read and discussed. The guest speaker was Dr. William A. Riley, chief of the Department of Entomology and Economic Zoology at the University of Minnesota. At the academy dinner on May 8, Dr. Riley spoke on the subject "Warfare of Man with Insects," and on the afternoon of May 9 his subject was "Some Native Parasites." Officers elected for the year 1931–32 are: *President,* B. B. Brackett, professor of electrical engineering, University of South Dakota; *First Vice-president,* George Gilbertson, professor of entomology, South Dakota State College, Brookings; *Second Vice-president,* Ralph E. Dunbar, professor of chemistry, Dakota Wesleyan University, Mitchell; *Secretary-Treasurer,* A. L. Haines, professor of chemistry, University of South Dakota. The next annual meeting will be held at Yankton College, Yankton.

THE first office of the U. S. Public Health Service to be opened in Latin America has been established in Mexico City, at the U. S. consulate, under the direction of Dr. Howard Franklyn Smith, major U. S. M. C.

MR. EDWARD S. HARKNESS will give to Columbia University a library building which it is planned to erect on South Field. It will face the Low Memorial Library, which will be used in the future for rare collections of books and manuscripts, for research workers and for the offices of the president, secretary and trustees of the university. The new library building will be designed to house four million books. Mr. Harkness's gifts to Columbia have exceeded $3,600,000. His gifts last year to charitable and educational institutions amounted to $31,000,000.

A PROGRAM to raise $14,000,000 as a preliminary step to putting the New York University and Bellevue Hospital Medical College development on the East River on a par with the Columbia and Cornell medical centers was tentatively outlined on May 10 by Mr. Percy S. Straus, at the ninety-second anniversary dinner of the Alumni Association of the college. New York University has acquired the land necessary for the project, Mr. Straus said, and the first aim is to raise $5,250,000 for the erection and maintenance of a College of Medicine Building, for which general plans already have been drawn. The medical center plan as a whole calls for ten buildings, some of which are already erected and need only to be enlarged and modernized, while others are in process of building. Mr. Strauss made no estimate of the total cost, but he said that the entire center could be built much more cheaply than were either the Columbia or Cornell centers because Bellevue Hospital has been built and is supported by the city.

THE council of the senate of the University of Cambridge issued a report on the proposed allocation of the "Rockefeller Benefaction." It will be recalled that the International Education Board offered to the university the sum of £700,000, provided the university could secure £479,000, and that the chancellor was able to announce at his installation last year that the university had received promises which would enable them to satisfy this condition. It is proposed to divide the total sum of £1,179,000 as follows: For the university library, £500,000; for agriculture, including the building and equipment of a new laboratory, £162,000; for biochemistry and biophysics, including a professorship of colloidal physics, £121,500; for botany, £108,500; for physiology, £87,700; for zoology, £168,400, and for physics, including the establishment of a professorship of mathematical physics, £30,000.

PRESIDENT HOOVER has written as follows to the Secretary of Agriculture: "In view of the manifest overproduction of wood products, it seems to me it would be of assistance both to the commercial situation and to the real conservation of our forests, if the Department of Agriculture would still further

temporarily restrict the leasing of the national forests for wood production. I believe it would be desirable now to more positively define the limitation of all leases by the Bureau of Forests except for pulp purposes in Alaska, to occasions when a sum of not more than $500 is involved and to cases where some cutting privileges must be given to actually maintain sawmills that are in operation, and this only where the mills can not obtain raw materials elsewhere. The only reason I am moved to make these exceptions is that we should not deprive farmers and small industries of wood supply and should not create local unemployment by inconsiderate action."

THE fifty-first annual meeting of the American Forest Association will be held jointly with the North Carolina Forestry Association at Asheville, North Carolina, on June 3, 4 and 5. Forest conservation as a function of state government will be discussed by Colonel Henry S. Graves, dean of the Yale Forest School, and at one time Chief Forester of the United States. America's land situation, with special reference to the southern Appalachians, will be presented to the conference by Dr. L. C. Gray, in charge of land economics of the United States Department of Agriculture, while R. Y. Stuart, chief forester of the United States, will speak on the national forests in a coordinated program of land use. The subject of state forests and parks will be presented by William G. Howard, superintendent of lands and forests of the State of New York. Dr. Wallace W. Atwood, president of Clark University, will tell of the meaning and place of the national parks. Other speakers will be Dr. Frank R. Oastler, of New York; Dr. Nehemiah Boynton, of Medford, Massachusetts, and James G. McClure, president of the Farmers' Federation.

THE committee on the Costs of Medical Care, of which Secretary Ray Lyman Wilbur is chairman, met in Washington on May 15 and 16. The committee, which has already given four years to the study of the problem, is not a government agency but is underwritten by a group of philanthropic agencies which include the Rockefeller Foundation, the Julius Rosenwald Fund, the Carnegie Foundation, the Russell Sage Foundation, the Twentieth Century Fund, the Milbank Memorial Foundation, the New York Foundation, and the Josiah Macy, Jr., Foundation. Five main questions are being studied by subcommittees: (1) To what extent should an attempt now be made in the United States, with due consideration to economic and geographic variations, to supply all the people's needs for medical service? (2) What general and specialized personnel and what buildings and equipment should be provided for supplying this medical service? (3) How may personnel and equipment be organized so as to insure the highest practicable quality of service and the maximum economies in the use of equipment, and of the time of both practitioner and patient, compatible with adequate return to the persons and agencies providing service? (4) Should there be agencies in local communities to plan for existing and future medical needs and to provide for the coordination of all medical services? (5) To what extent should payment of medical services be based upon individual purchase or upon group purchase?

THE Second International Congress of the History of Science and Technology, as already announced, will take place in London, England, from June 29 to July 3 of this year, with the Science Museum, South Kensington, as its headquarters. The executive committee is hoping to arrange an exhibition of books and periodicals dealing with the history of science and of technology, at the headquarters of the congress throughout the week. Publishing firms interested in this event should send to the assistant honorary secretary of the congress, Science Museum, South Kensington, London, S.W. 7, a list of books which they consider suitable for exhibition. No charge will be made for exhibition-space, but the executive committee will expect publishing firms to undertake the cost of transport of books both to and from the museum.

THE Association of American Medical Colleges announces that the statistical work on the study of the performance of medical students during their first year in medical school is completed. The freshman class of 1929 was recruited from 591 liberal arts colleges. Each one of these colleges may obtain a record of the students they sent into medicine by writing to the secretary of the association, Dr. Fred C. Zapffe, 25 East Washington Street, Chicago, Illinois. The association undertook this work to establish cooperation between the liberal arts and the medical colleges with the expectation that a better understanding of aims of both groups will result.

THE New York State College of Forestry, Syracuse, New York, has been notified by Sven Petrini, the secretary-general of the International Union of Forest Research organizations, Experimentalfaltet, Sweden, of its election to membership in the International Union of Forest Research organizations. In addition to the New York State College of Forestry there are five other forestry institutions belonging to the union in the United States—the Harvard Forest; the Yale School of Forestry; School of Forestry and Conservation, University of Michigan; Forest Soil Laboratory, Cornell University, and the California

Forest School of the University of California. Germany has the largest membership embracing eight institutions, Great Britain has six and other foreign countries from one to three memberships.

The Department of Geology at the University of Illinois, through the courtesy of Dr. John B. Reeside, Jr., of the United States Geological Survey, has received a gift from the United States National Museum of a collection of Mesozoic plant and invertebrate fossils.

We learn from *Nature* that the Pontifical Academy of Sciences (Nuovi Lincei) is offering a prize of 10,000 lire for a critical dissertation on the law of Mendel and the chromosome theory. Essays must be unpublished and may be written in English, French, German, Spanish, Italian, or Latin. They may be signed or written under a pseudonym, and must reach the Pontifical Academy of Sciences, The Vatican City, before October 30. The award will be announced at the first meeting of the academy in December.

DISCUSSION

BIOLOGICAL ABSTRACTS

Biological Abstracts is intended to serve as a comprehensive abstracting journal of the entire literature of biological research of the world. The first number appeared in December, 1926, and the fifth volume is now in course of publication. Its subscription price is $15.00 per volume. It is the only publication in the world that pretends to cover the entire field of biology. Our German colleagues in order to obtain an equally comprehensive service would have to subscribe to ten abstract journals in theoretical biology at a cost of $382.50 per year, and to some at least of the journals in applied biology which collectively cost $305.00 a year additional. There would be, of course, an immense amount of duplication in such a collection of the admirable German abstracting journals. But the comparison will serve at least to indicate what an enormous undertaking it has been to organize a single journal which eliminates all duplication. If the performance of *Biological Abstracts* to date gives good promise of realization of its aim, there would be few to deny that it is a contribution to the service of biological research worthy of a high institutional rank.

It is not necessary to argue the case of the need of a reference system that will be something more than merely bibliographic before biologists of any one of the numerous persuasions. Whether those who grew up under the relatively simple conditions existing before the war are more convinced than those to whom the present intense worldwide activity and cooperation in scientific research seems of the order of nature is perhaps a matter of indifference, for neither the veterans nor the recruits are able without the aid of a comprehensive abstracting journal to view the entire biological front with its thousands of media of publication, whatever may be possible within a small field of investigation. And it is becoming increasingly important in genetics, in physiology, biochemistry and biophysics, in pathology and bacteriology, in ecology, in cytology and other disciplines within biology, to know not only what is being done by the zoologists, but also by the botanists, and not only in academic institutions and museums, but also in the medical schools, the institutes of agriculture, in the fisheries and oceanographic institutes, to name only some of the organizations in applied biology. Each piece of work has some taxonomic implication, so that the bad tradition that has separated systematists and workers in fields of more general biology should be broken down. If *Biological Abstracts* is really comprehensive, it is not only a great convenience, but it is a great unifying force in the life-sciences, and hence an agency of scientific progress.

It has been said that it is an impossible undertaking, but at present about 5,500 periodical publications out of a total of about 6,000 are being abstracted for their biological content. It will not require much extension to make the survey practically complete. Abstracts are furnished in part by authors, and to a great extent by some 3,000 collaborators scattered in all countries where biological research is in progress. Yet the resulting volumes, owing to special format and thin paper, are not unwieldy. The progress that has been made in these five years in completeness of references is guarantee of a fully satisfactory representation of the literature. The main criticism that can be made up to the present is the slowness in appearance of the index numbers, without which use of the volumes is rather painfully slow. But the recent appearance of the index number to the first volume is evidence that the difficulties connected with this essential part of the service have been overcome. It is to be hoped that the index numbers of the succeeding volumes will now be expedited. Already *Biological Abstracts* has a subscription list of over 3,000, which is greater than that of any other biological publication in America. It has been demonstrated not only that

the undertaking is possible but that it is very widely welcomed.

Biological science does not have back of it extensive, well-organized and highly paying commercial organizations dependent on the progress of the science and contributing to its development and support, such as exist in the case of chemistry, for instance. Although the applied aspects of biology in medicine, in agriculture and fisheries are of at least equal human significance they are not organized as commercial enterprises, and hence can not contribute directly to the support of *Biological Abstracts*, as can the commercially organized chemical industries to *Chemical Abstracts*. For a long time to come, then, *Biological Abstracts*, if it is to continue, must depend on the support of enlightened philanthropy. At present its earned income from subscriptions and other sources is sufficient to pay manufacturing costs only. This agrees with the original estimates drawn up before the project was under way. But the great items of cost, consisting of editorial, indexing, bibliographic, secretarial and clerical services, which make up from two thirds to three quarters of any adequate operating budget, must be specially provided. This constitutes an enormous "overhead" which exists whether the subscription list be large or small. It is estimated to amount to over $100,000 for 1931. This is obviously a situation in which every biologist can help, by his subscription. It is, however, not expected that even with the largest list of subscriptions practically possible, the overhead charges can be paid by the receipts of the journal.

The whole enterprise of biological research is, however, so vast and its human usefulness so inestimably great that such a sum seems to be only a small tax upon it; indeed, almost vanishingly small compared with the immense sums required for primary costs of the research and original publication. If the journal should acquire still more of an international character, the tax on American biologists and American philanthropy might be correspondingly reduced; but it seems to the writer that American biologists and philanthropists who have the advancement of science at heart should not withdraw their support until the future of this comprehensive abstracting service is adequately safeguarded.

Frank R. Lillie

University of Chicago

TWISTED TREES

I have read with interest the notes in Science for February 13 and March 27 dealing with trees with twisted bark. My observations covering a large part of the province of Ontario, Canada, may be of interest in this connection. In this region I have often noted the twist of evergreens, especially of the cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), Norway pine (*Pinus resinosa*) and Jack pine (*Pinus divaricata*). I have never noted it on a "hardwood" in the region. In the cedar the twist is very common, straight-grained trees being far less abundant than twisted-grained. Last summer I camped on an island in Lake Kahnipiminanikok, and my party amused itself one rainy day noting this twist on cedars, some one having discovered the predominance of right-handed twists. We counted (from my notes) 312 cedars on the island; of these 219 were twisted; of these 187 were right-handed twists. Later an Indian emphasized the need of straight-grained cedars in the hewing of paddles, and the difficulty of obtaining such grains in that vicinity. He also pointed out the fact that the twist is more common in large trees than in young ones, indicating that this character is acquired by some environmental factor. This twist is not alone in the bark, but in the wood as well. It is frequently so extreme as to be a spiral. Among the white and Norway pines the twist is far more common in trees exposed to severe weather conditions, especially to strong winds. Thus I noted that twisted trees occurred more commonly on exposed rocky cliffs and small, open islands, where they receive the full brunt of winter gales. A twisted tree in the heart of the forest is quite rare. But why do they twist so predominantly to the right?

A. R. Cahn

Urbana, Illinois

THE MECHANISM OF CROSSING-OVER

Dr. Sax[1] has recently put forward a theory that crossing-over is due to the breaking of chiasmata in the course of terminalization. This theory is based on a suggestion of mine[2] that "crossing-over is occasioned by breaking of chiasmata." Moreover, Sax uses diagrams and terminology that are borrowed from my studies and therefore imply an interpretation in accordance with my findings.

I should like to point out therefore that I do not consider the original conjecture in any way supported by Sax's observations. I discarded the idea a year ago for reasons that are described in the accounts of studies conducted in this laboratory by Erlanson,[3] Philp and Huskins[4] and myself.[5,6,7,8,9] Briefly, the

[1] K. Sax, "Chromosome Structure and the Mechanism of Crossing-over," *J. Arnold Arboretum*, 11: 193–220, 1930.

[2] C. D. Darlington, "Meiosis in Polyploids, II. Aneuploid Hyacinths," *J. Genet.*, 21: 17–56 (see p. 52), 1929.

[3] E. W. Erlanson, "Chromosome Organisation in *Rosa*." *Cytologia*, 2 (in the press).

[4] J. Philp and C. L. Huskins, "The Cytology of *Matthiola incana* R. Br.," (especially in relation to the inheritance of double flowers), *J. Genet.*, 24 (in the press).

reasons are twofold: (1) Frequencies of chromosome pairing and of kinds of configurations occur that can be predicted only on the assumption that chiasmata do *not* break in terminalization: (2) configurations occur in polyploids and structural hybrids that are only compatible with the alternative hypothesis that crossing-over has preceded (and determined) chiasma formation. Sax's genetical remarks might be taken to favor either hypothesis—for there is no decisive evidence between them. They are however vitiated as evidence by his using the word "chromosome" in three different senses, *e.g.*, p. 209, l. 25 to mean one chromatid, l. 27 (?) two chromatids, and l. 28, four chromatids.

C. D. DARLINGTON

JOHN INNES HORTICULTURAL INSTITUTION,
LONDON

ADVANCES IN THE BIOLOGICAL SCIENCES

THE inclusion of the notes compiled by Science Service on the advances made in various branches of science during each year is a valuable feature of your paper. Permit me, however, please, to make a few comments on two of the 1930 items.

The tannic acid treatment of burns, originated by Dr. E. C. Davidson, of Detroit, was first published by him as far back as 1925. In 1929 the British Medical Research Council published a memoir by Mr. W. C. Wilson, of Edinburgh, and the results given in it "wholly confirm the claims made by Dr. Davidson for the tannic acid treatment."

Another item given in the 1930 list is the use of a neon lamp, connected in parallel with a condenser, to measure a small electric current. This device was applied by Dr. H. C. Rentschler, director of the research laboratories of the Westinghouse Lamp Company, to the measurement of the photo-electric current from a uranium cell, sensitive to ultra-violet light only. As far as I know his work was published during 1930. The same method, with minor differences, had, however, been published by Dr. J. H. J. Poole, of Trinity College, Dublin, in 1928, in the *Scientific Proceedings* of the Royal Dublin Society. When reading his paper before the society, Dr. Poole established that the rate of flashing was proportional to the photo-electric current from a sodium cell, and demonstrated the flashing to the audience by means of a two-valve amplifier, so that each flash was heard as a rap.

Through the courtesy of Dr. Poole I was able similarly to demonstrate the flashing in a course of lectures in London University in May, 1929.

At the joint discussion on photo-electric cells, held by the Physical and Optical Societies in London on June 4, 1930, J. H. J. Poole and H. H. Poole communicated a further paper on the neon discharge tube method, and gave the results obtained for the absorption coefficient of the water of Lough Bray, in the Dublin Mountains, during August, 1929. In the autumn of the same year Dr. H. H. Poole and the writer collaborated in the use of the method for submarine photometry. For this it has many advantages, as it integrates the current over a suitable time interval and permits one to obtain correct values in which the effect due to dancing of the waves is averaged out. About the same time, and since, we used the apparatus for measuring in various situations the color of daylight (and other light sources, carbon arc, etc.) with a photo-electric cell, and more recently for the study of a mercury vapor arc. Accounts of these applications are now in the press.

The method has many uses. It appears to have been invented by Dr. J. H. J. Poole, and later by Dr. Rentschler, quite independently.

W. R. G. ATKINS

MARINE BIOLOGICAL LABORATORY,
PLYMOUTH, ENGLAND

LITERATURE RELATING TO COD LIVER OIL

IN our recent "Report to the Empire Marketing Board on the Relative Values of Cod Liver Oils from Various Sources" (E. M. B. 35) an unfortunate blunder has arisen during the revision and proofreading of the introductory chapter.

Reference 6 on page 9 is incorrectly given and should, of course, refer to the important paper by Professor Steenbock and his colleague Dr. Boutwell in the *Journal of Biological Chemistry* (1920, vol. 42, p. 131).

Immediately our attention was drawn to the error we wrote to Professor Steenbock expressing our great regret and, although he desired that we should give no further attention to the matter, we feel that we must override his wishes and make public our correction of the mistake.

On the same page the reference to Professor E. Mellanby's pioneer researches on the causation of rickets might suggest that his results were not published before 1921. We were, of course, well aware of his earlier contributions to the subject but thought it better, in a brief summary, to refer the reader to the full account of his earlier work which was published by the Medical Research Council.

[5] C. D. Darlington, "A Cytological Demonstration of 'Genetic' Crossing-over," *Proc.* Roy. Soc., 107: 50–59, 1930.

[6] C. D. Darlington, "Studies in *Fritillaria* III: Chiasma Frequency and Chromosome Pairing in *Fritillaria imperialis*," *Cytologia*, 2: 37–55, 1930.

[7] C. D. Darlington, "Meiosis in Diploid and Tetraploid *Primula sinensis*," *J. Genet.*, 24: 65–96, 1931.

[8] C. D. Darlington, "Meiosis," *Biol. Rev.* 6, (in the press).

[9] C. D. Darlington, "The Cytological Theory of Inheritance in *Oenothera*," *J. Genet.*, (in the press).

We would like to express our apologies to these distinguished investigators.

J. C. Drummond
University College, London
T. P. Hilditch
University of Liverpool

INSCRIPTIONS FOR A SCIENTIFIC BUILDING

Ursinus College is erecting a new building for instruction and research in the sciences. It will be a rather imposing structure for a small college. On the face of the building at either side above the front entrance inscriptions are to be cut. The space permits each text to consist of about seventy letters. They might be quotations or original compositions.

I am seeking suitable inscriptions and shall be under obligations to any reader of Science who may be willing to send suggestions.

George L. Omwake,
President
Ursinus College,
Collegeville, Pennsylvania

SCIENTIFIC BOOKS

A History of Entomology. By E. O. Essig. The Macmillan Company, New York, 1931. 1,029 pp., $10.00.

Despite its inclusive title, this work treats primarily of the history and development of applied entomology in California. It is replete with valuable and interesting information on this and related subjects.

Should one insist on the definition of history as "a narrative of events," then some of the contents of the work could not qualify in that category. Nevertheless, the evidence of intelligence in the choice of material, the conscientious accuracy and completeness of the data included, and the evident effort of the author to render the work of the utmost use to the reader, all evoke his admiration and respect.

In perusing these pages, one is certain to be deeply impressed, too, with the early and leading part taken by the people of California in the advancement of applied entomology and its concomitant activities in America. Settled as it was, after the hegira of 1849, by a virile race of hardy pioneers, California's specialized forms of agriculture, which almost from the first have produced crops of high intrinsic value, together with the great wealth produced by the swift development of her mineral resources, soon gave her a surplus of vigor and power which account in large part for the courageous manner in which she has attacked not only her entomological problems but her civic and social emergencies as well. Thus she was the first of all the states (Howard[1]) to protect herself (in 1880) by legislation and quarantine against the introduction of new insect pests. And this is but one illustration of her forward-looking and aggressive spirit. Her leadership among the states, in the investigation of fumigants and chemicals for the destruction of insect foes, and her early successful adoption of biological methods of insect control, all evince the same qualities of vitality and courage as were exhibited so marvelously after the great earthquake and fire of 1906.

If, as seems possible, it be true that several serious insect pests such as the cottony-cushion scale, San José scale, black scale, etc., gained entrance to America through the activities of the early horticulturists of California, the world will learn through these recent expositions of entomological history that she has atoned nobly for such unintentional lapses by her innumerable valuable contributions to the control of these and of other insect pests for which she has been in no way responsible.

The opening chapter of the present work treats very briefly of the paleoentomology of California, while the second chapter is devoted to an entomology of the Californian Indians. This occupies some thirty-six pages and is of general interest but has a marked ethnologic flavor. After a few pages giving the general historical background, the origin and present status of the Californian institutions pertaining to entomology are related in which discussion the universities and colleges are given individual attention. Then follows a section comprising 192 pages, discussing the history of "The More Important Orchard Mites and Insects of California." With one exception (that pertaining to biography), this chapter is the longest in the book and is considerably more comprehensive than is indicated by its title. For instance, it includes important pests of forage crops, ornamentals, vegetables and even insects affecting health such as the fleas and some mosquitoes. A circumstantial account of the history of sericulture in California and a brief discussion of apiculture in the state conclude the chapter.

The matter is arranged ordinally, beginning with the Acarina, without regard to chronological sequence. A brief history of each species is given together with its common and scientific names. This often includes the formulae used in control, and numerous refer-

[1] L. O. Howard, "A History of Applied Entomology," Smithsonian Inst., Nov. 29, 1930.

ences to the literature of the insect are carried in voluminous footnotes.

The fascinating subject of the biological control of insect pests is treated extensively in a chapter of 129 pages. Here, of course, is found the somewhat hackneyed but ever dramatic tale of the introduction of the Australian ladybird by Koebele and Coquillett in 1888, and the consequent salvation of the citrus fruit culture in California. It is not too much to say that the spectacular success of this project has had a far-reaching and profound effect on the development of economic entomology in America. The idea of "a bug to eat a bug" is still so popular that the administrative officials of the Federal Bureau of Entomology are sometimes compelled to apply the brakes to ill-advised popular movements which would appropriate government funds in excess of those which can be legitimately expended for the introduction of useful parasitic insect enemies.

In passing it might be of interest to remark that the arrangement of the present work in chapters which bear no chronological relation to each other has compelled the author to numerous repetitions which would have been avoided had it been possible to carry his narrative through consistently as a continuous story. For instance, the story of the Australian ladybird introduction is repeated, at least in part, in five different chapters of the book, thus entailing both additional labor and expense for the author and a lessening of sustained interest on the part of the reader. However, it is but just to the author to say that the difficulties to be surmounted in preparing such a chronological narrative are many and formidable and had this plan been adopted it might have resulted in a less complete exposition of the subject.

Extensive tabulations showing the various introductions of the Australian ladybird and other coccinellids into California, as well as much similar information, are given in this chapter. The Hymenopterous parasites are allotted more than 50 pages in which those of the scale insects and mealybugs are most fully treated, including members of the Aphelinidae and Encyrtidae. There is included at this point an interesting account of the collectors of foreign parasites, including the work of Albert Koebele, George Compere, Henry Viereck, E. J. Vosler and others. It ends with a long tabulation of "The Most Important Parasitic and Predacious Insects Introduced into California Following the Work of A. Koebele," and a discussion of California insectaries. Following this there are one hundred pages devoted to a history of the commoner insecticides and their application principally from a Californian point of view. In these, formulae both ancient and modern are discussed. Quite properly, the discovery and development in 1886 of the fumigation of citrus trees with hydrocyanic acid gas for the destruction of scale insects, by Daniel W. Coquillett, an agent of the Federal Department of Agriculture, is fully related. Since the invaluable services of this able man both to applied entomology and its taxonomy have not hitherto been given appropriate recognition it is gratifying to see them assigned a prominent place in this historical work. This chapter ends with an account of the development of fumigation under vacuum, by Sasscer and Mackie.

As California pioneered in entomological legislation it would have been disappointing had a succinct history of this phase of entomology been omitted in the present work, but we find some 38 pages devoted to this subject. Here is told the origin of the organizations which preceded the creation of the State Department of Agriculture in 1919 and the functions they performed in protecting the rapidly developing agriculture of the state. Suitable mention is made of the integration of state and federal forces.

In none of his many excellent writings has Dr. Essig performed a more acceptable and valuable service to science at large than in the compilation of the 270 pages of biographical matter which comprise Chapter IX of the present work. Well-prepared biographies are always valuable, but until now the biographical data relating to the entomologists, a group of more or less obscure men at best, have remained scattered through the general literature of the subject or hidden away in inaccessible records. The collation and publication of this information will be welcomed by all and the more so because of the good portraits which accompany it. Regarding these biographies the author says, "It was my original purpose to include in this chapter a short biographical sketch of every one who had contributed to the development of entomology in California and it is a real disappointment to me not to be able to carry out my plans." When it is known, however, that the chapter includes most of the notables in entomological history who have had the most remote connection with California, from Linnaeus and Fabricius in the middle of the eighteenth century to L. O. Howard and Herbert Osborn, of the present day, it would seem that Dr. Essig might rest content that something remains for future historians to do. Very many of the biographies included are accompanied by more or less full bibliographies of the individual concerned.

The book terminates with "A Chronological Table Showing the Development and Progress of Entomology in Relation to History and Other Sciences." The arrangement of this material is somewhat puzzling as in both the natal column on the left, and the mortuary data headed "Deaths" on the right, two separate dates are recorded for each individual; if

would appear from this that such distinguished personages as Columbus, da Vinci and Copernicus were born twice! But, what is far worse, that such benefactors as Peter the Great, Hans Sloan and Galileo Galilei suffered a double death! It used to be said that "oil and water will not mix," but we entomologists now know very well that there is such a thing as a miscible oil. However, history and fiction are alleged to be utterly incompatible—I wonder? Seriously speaking, this chronological table will be of great service to students of entomological history.

This is a well-built book. It is bound in keratol, printed on thin, calendered paper, and although it is but little more than one and one half inches thick, it weighs about three pounds!

W. R. Walton

Bureau of Entomology,
Washington, D. C.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE SHAPOMETER: A DEVICE FOR MEASURING THE SHAPES OF PEBBLES

For several years the senior author has been interested in methods used for calibrating the shapes of pebbles, and he has been working on a method which could be used by a number of workers and yield comparable results. In a paper published recently[1] he described a method which has been tested during the last two years by a number of students in connection with their research problems. The validity of the method became apparent not only for grains of sand size but also for pebbles, cobbles and small boulders. A method by which the shapes of sand grains may be measured by using a petrographic or binocular microscope was suggested in the paper just cited, and the statement was made that the instrument to be used in measuring pebbles and cobbles would be described later. The instrument is called a *"shapometer."* The general idea of the shapometer was suggested to the junior author who perfected it and measured several hundred pebbles to prove the utility of the instrument.

According to the method proposed by Tester,[2] the shape of any pebble measured is the ratio of abrasion to the original angularity, and measurements are made of the remnant sides or edges and of the projected original edges. Hence, a simple instrument with three or four straight edges calibrated in small units and with movable slides or pivots will suffice for measurement. Fig. 1 is a generalized sketch of the shapometer with 1 mm divisions on the main parts. The lower member "A" is graduated and slotted as shown, to permit an easy sliding of scale 'C.' Scale 'B' is attached to 'A' by a fixed

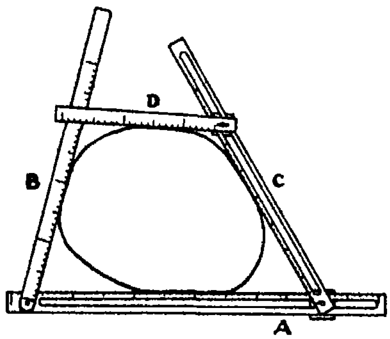


Fig. 1

pivot and although it will not slide it will make with "A" any angle desired. Scales 'B,' and 'D' are graduated in the same units as 'A.' Experience shows a millimeter scale to be satisfactory. Scale 'B' is solid, but 'C' is slotted to permit the attachment of a fourth scale 'D.' Scale 'D' is provided with a screw so it can be removed, but it is very useful when measuring a section of a pebble which has four or more principal surfaces.

The instrument may be constructed of stiff cardboard, celluloid or light weight metal. The writers have used the common 6 inch celluloid millimeter scales with considerable success, but aluminum bars are ideal. The scale 'A' is 7 inches long over-all length.

[1] A. C. Tester. "The Measurement of the Shapes of Rock Particles," *Jour. Sed. Petrol.*, Vol. 1, No. 1, 1931.
[2] *Op. cit.*

TABLE I

Surface or side measured	A	B	C	D
Projected lengths or original edge	44	28	31	22
Length of remnant edge	14	9	10	8
Ratio of remnant to original edge (angularity ratio)	$(\frac{14}{44})$ 31.8%	$(\frac{9}{28})$ 32.1%	$(\frac{10}{31})$ 32.2%	$(\frac{8}{22})$ 36.3%
Ratio of abraded to original edge (abrasion ratio)	$(\frac{30}{44})$ 68.2%	$(\frac{19}{28})$ 67.9%	$(\frac{21}{31})$ 67.8%	$(\frac{14}{22})$ 63.7%

Average abrasion ratio or roundness = 66.9%.

The use of the shapometer is illustrated best by a study of Fig. 1 in which a pebble is shown in one of the three principal positions. The graduations on the scale are in millimeters. The following table shows the nature of the readings.

The junior writer has found that a smaller shapometer with a range of 75 mm instead of 150 mm is advantageous for measuring particles below 40 mm. The greater ease of handling the smaller instrument insures more accurate and rapid results.

Allen C. Tester
H. X Bay

Sedimentation Laboratory,
State University of Iowa

APPARATUS TO CIRCULATE LIQUID UNDER CONSTANT PRESSURE IN A CLOSED SYSTEM

This apparatus is designed to circulate a liquid and to maintain a constant pressure in a sterile system, without the use of joints or moving parts in contact with the circulating liquid.

The apparatus is a single piece of glass. Pressure is maintained by the head of liquid and the liquid is raised and kept in circulation by placing the apparatus on a tilted base which is given a circular motion without being permitted to rotate. This motion carries the liquid up the coil and into the top reservoir. Gases can be introduced through the tube half way up the coil, and an internal pressure can be maintained, if desired, by the displacement of water or other fluid by the exhaust gases.

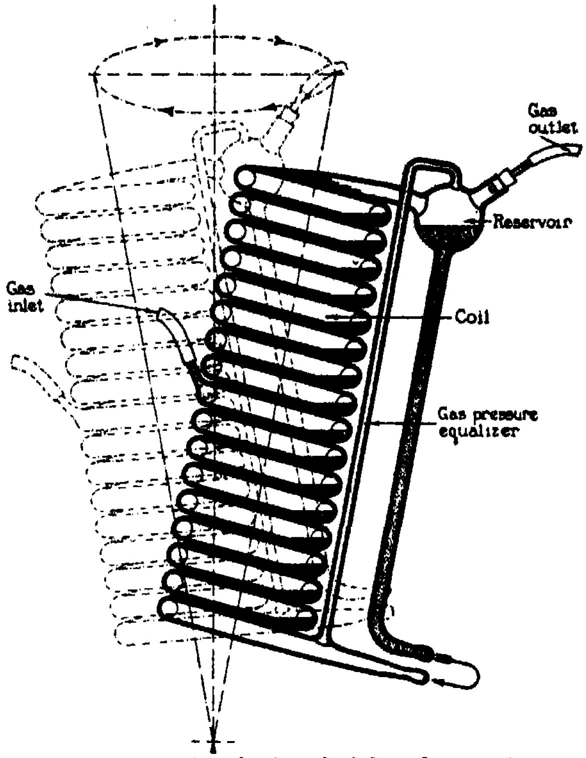


Diagram to show basic principles of apparatus.

Division of Experimental Surgery,
Rockefeller Institute
for Medical Research

SPECIAL ARTICLES

GROWTH OF PLANTS UNDER CONTINUOUS LIGHT

Studies carried on by the writer since 1926 with plants illuminated both day and night seem of sufficient interest to report upon briefly at this time. Others who have tried somewhat similar although not exactly the same experiments[1] seem not to have secured just the results which have been so apparent in my work. Preliminary accounts of my studies were made at meetings of the Southwestern Division of the American Association for the Advancement of Science in Santa Fe, 1927, and in Flagstaff, 1928. The experiments are being continued, and a full account will be published at a later time.

Plants, chiefly annuals, have been grown in the greenhouse under natural light in the daytime and, in addition, during both day and night they have had the light of two 100-watt Mazda lamps suspended above the bench at a distance of four feet—the lamps provided with an overhead reflector. Controls, shielded from the artificial light, are growing in the same room of the greenhouse on the same bench at a distance of about ten feet. A total of nearly one hundred species have been worked with, some of them during two or more seasons if first results seemed doubtful. The list includes common garden vegetables, grains, weeds, native herbs and garden ornamentals.

In general, the experimental plants are taller than the controls at all times during the entire growth period, this increased height being due to elongation of internodes. Frequently the experimental plants are slender-stemmed and have a decumbent habit. Flowering is usually hastened under continuous light but in a few species is completely inhibited. Plants of some species reach full adult stature, come to blossom, and produce fruit and seed while the check plants are still in the rosette stage close to the ground.

The root system in plants of the experimental series is invariably less extensive than that of the controls; roots are smaller, shorter, and have fewer branches. Thickened taproots do not develop.

[1] J. Adams, *Amer. Jour. Bot.*, 12: 398, 1925. R. B. Harvey, *Bot. Gaz.*, 74: 447, 1922.

Leaves of plants under continuous illumination often show no modification but in a considerable proportion of the species studied they have smaller, thinner blades, and often longer petioles. Leaves of monocotyledons tend to be very much lengthened as do the sinuately deeply-cleft leaves of certain Hydrophyllaceae. Reduction in leaf size is especially noticeable in certain members of the chickweed family, and this with the thin stems and greatly lengthened internodes and frequent paleness of color gives a suggestion of etiolation. But only a few species are sufficiently pale or show the leaves so much reduced as to make the similarity to etiolated plants very pronounced. The greatly lengthened internodes are, however, a practically constant feature.

Internally, the stems of plants grown under continuous light show a thinner cortex, less vascular tissue (especially phloem), and a relatively larger pith than the controls. Leaf-blades in cross-section look as if derived from plants grown in the shade, usually having a single layer of palisade and with more and larger intercellular spaces than the plants grown under ordinary greenhouse conditions. Leaf cells are smaller, hence the leaves are thinner. Roots of the plants of the experimental series show slight development of phloem but otherwise are of usual structure, except that as previously noted they are small and short and with few branches.

FRANCIS RAMALEY
UNIVERSITY OF COLORADO

A MAXIMUM POINT IN AN EFFECT OF PROLONGED X-RAY IRRADIATION UPON DROSOPHILA LARVAE

IN a previous report[1] from this laboratory certain effects of X-ray irradiation upon drosophila larvae have been presented. It was found that under the given conditions the mean duration of the prepupal period, φ, (the interval, expressed in days, between the laying of the egg and the formation of the pupa) was an increasing function of the period of irradiation, t. In the work referred to the maximum irradiation interval was six hours, which was taken as a limit to the time for subjection of the larvae to the unnatural environment as well as to the continuous operation of the X-ray tube. As has been stated, an increase of X-ray radiation power was not possible at that time. In view of these circumstances observations were made concerning the effect of radiations of longer wave length with the idea of obtaining more extensive changes. We do not assume, however, that effects of radiations of different wave length are the same. Accordingly, radiations filtered with only 3 mm of cardboard were employed, using a Coolidge air-cooled tube (tungsten target) impressed with a potential difference corresponding to a spark-gap reading (between 12.5 cm spheres) of 2.0 cm and a tube current of 8.0 M.A. with otherwise the same X-ray apparatus.

[1] R. Hussey, W. R. Thompson and E. T. Calhoun, SCIENCE, 66: 65–66, 1927.

Larvae were prepared for irradiation and maintained in the same manner as in the work previously reported,[1] except that they were irradiated in wells in paraffin blocks 125 mm square by 35 mm in thickness. The wells were cylindrical (25 mm in diameter and 5 mm deep) and were situated with axis 25 mm from a corner on a diagonal of a square face of the block—one such well in each block. Just prior to irradiations approximately 200 larvae were placed in each of eight such wells and covered with perforated filter-paper permeated with paraffin as described in the earlier work.[1] Four of these blocks were then placed with wells uppermost upon the same plane with the adjacent corner at a point 30 cm vertically beneath the center of the target of the X-ray tube. Periods of irradiation were so chosen that the following scheme could be employed.

The irradiation intervals were seven successive multiples of 35 minutes up to 245 minutes; so that, with the exception of the last, they could be arranged in pairs whose sum was 245 minutes. Accordingly, with just four blocks in position at all times (as described above) it was possible by means of substitution at

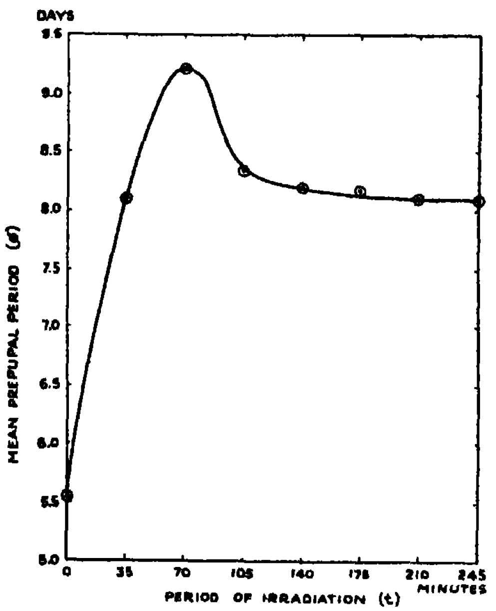


FIG. 1

the proper time of the other member of each pair to complete all the irradiations within the same interval employed for the longest. The eighth block was kept in the same room but shielded from the radiations, and thus corresponded to a zero irradiation interval or control.

Eight independent experiments of this sort were made, the orientation of the respective blocks being successively interchanged as was also the order of irradiation of the respective pairs so that positional or such chronological difference might not influence the means of all these results. These mean values of φ together with the corresponding periods of irradiation, t, are given in the table and represented

TABLE I

t (in minutes)	φ (in days)	A.D.	t (in minutes)	φ (in days)	A.D.
0	5.55	.06	140	8.20	.07
35	8.09	.11	175	8.18	.07
70	9.24	.09	210	8.10	.08
105	8.36	.10	245	8.09	.08

graphically in the figure. In the table also is given the A.D. of each mean (the mean deviation divided by $\sqrt{8}$) which is employed as a precision measure.

The indication of a maximum point on the graph in the interval, 35 to 105 minutes, is statistically significant, and the decline followed by attainment of an almost level plateau is a surprising result. Here, too, the precision measures indicate that this is not due to mere chance.

ROBERT TENNANT, JR.
DEPARTMENT OF PATHOLOGY,
YALE UNIVERSITY

THE EFFECT OF SUNLIGHT ON HUMAN BLOOD CELLS

EXPERIMENTS were made to elucidate the action of sunlight on human cells under the condition of general insolation. The first experiments concerned the cells which are easiest to obtain, namely, the red blood corpuscles. The results of these experiments are described below.

It was found first that, in accord with the results obtained by Pfeiffer and Bayer, Hausman and Loewy, and Löhner, red corpuscles suspended in a salt solution exposed to direct sunlight gradually disintegrate and hemolize. This disintegration occurs, however, only if the corpuscles are illuminated by intensive sunlight (clear sky, dry air, at noon). Under such condition the first hemolysis is noticed 10 minutes after beginning of insolation. Diffuse sunlight does not produce any hemolysis. Further experiments show, however, that even diffuse light which is fifty times as weak as direct sunlight makes the corpuscles less resistant and accelerates their spontaneous hemolysis when after the illumination they are kept in the dark in a physiological salt solution. After the exposure of the suspension of corpuscles to direct sunlight their resistance against poisons and hypotony is markedly diminished. But among the rays of sunlight only visible rays decrease this resistance. If the corpuscles are exposed to direct sunlight in quartz tubes no decrease or even an increase of the resistance is observed. Special experiments showed that ultra-violet rays, if they are weak or act for a short time, increase the resistance of the corpuscles and protect them against the harmful effect of visible rays. However, strong ultra-violet rays from a mercury vapor lamp destroy the red corpuscles.

In *in vivo* experiments it was found that a total insolation of men lasting 10 minutes (December, January, in Arizona) increases the resistance of young red corpuscles and decreases the resistance of old corpuscles, the latter being more sensitive to visible light. The insolation of the same men for one hour increases the resistances of all their corpuscles very markedly, but only if the sunlight contains a sufficient amount of ultra-violet rays (clear sky). This increase of the resistance is not lasting and disappears within twenty-four hours. When the sky is partially covered by clouds and the humidity is high or when sunlight is filtered through glass plates (6 mm thick) a marked decrease of the resistance of all corpuscles is observed, and this decrease does not always disappear within twenty-four hours.

The author's experiments twenty years ago showed that the permeability of protoplasm of plant cells for water soluble substances is greater in light than in the dark. This observation was confirmed later by many scientists not only on plant but also on animal cells. We might expect, therefore, the same action of light on red corpuscles. Indeed the present experiments show that the permeability of red corpuscles for water soluble substances is increased by sunlight, and this effect is due to the visible light in this case, too. Human red corpuscles were investigated in respect of their permeability for grape sugar. It may, therefore, be assumed that the nutrition of red cells is enhanced by the action of sunlight. As the chemical and physical structure of red corpuscles is similar to that of colorless cells, the results obtained on red corpuscles can be extended to all cells of our organism, and it is likely that sunlight increases the nutrition of our organism in general.

W. W. LEPESCHKIN
FROM THE LABORATORIES OF THE
DESERT-SANATORIUM AND
INSTITUTE OF RESEARCH,
TUCSON, ARIZONA

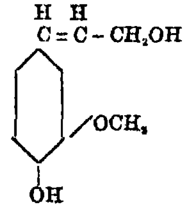
THE ISOLATION OF NORMAL PROPYL GUAIACOL AS A DEGRADATION PRODUCT OF LIGNIN

THE woody portions of plants, such as cobs, hulls, stalks, leaves, trunks of trees and shrubs, are composed

principally of carbohydrates, mostly cellulose and pentosans, and a complex designated as lignin. The latter is an amorphous substance ranging in color from light brown to black, depending on the method used in its isolation.

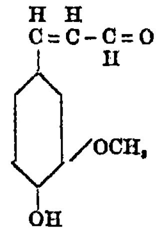
Commercially, lignin is obtained as a by-product in the preparation of paper pulp from wood. When wood is digested either with a calcium bisulphite solution or sodium hydroxide or sodium hydroxide and sodium sulfide solutions, under pressure, the lignin is dissolved, leaving the cellulose in a more or less pure state. The lignin obtained in this operation is generally discarded, and its disposal aggravates seriously the river pollution problem. When one considers that in this country alone approximately 1,500,000 tons of lignin are annually discharged from the various pulpwood mills, the wastefulness of this operation will be readily realized. Furthermore, there is produced annually on the farms of this country millions of tons of various agricultural waste materials, such as cornstalks, corn-cobs, cereal straws, flax straw and hulls, 10 to 20 per cent. of which is lignin. The fact that lignin now constitutes an enormous industrial and agricultural waste material has stimulated great research activity, on the fundamental chemistry and the economic utilization of this natural product.

Although lignin has been studied by chemists for nearly a century, the chemistry of this substance is still obscure. Considerable difference of opinion prevails among investigators as to whether this substance belongs to the aliphatic, aromatic, hydroaromatic or heterocyclic series. Among the advocates of an aromatic structure for lignin may be mentioned Klason,[1] Kürschner[2] and Freudenberg[3] and coworkers. On the other hand, Willstätter and Kalb,[4] Jonas[5] and Marcusson[6] contend that lignin is either hydroaromatic or belongs to the heterocyclic series. Klason has modified his conception of the structure of lignin from time to time, but he has generally assumed that it is structurally related to coniferyl alcohol (I)



Coniferyl alcohol (I),

or coniferyl aldehyde (II)



Coniferyl aldehyde (II).

Kürschner assumes that lignin is a polymer of the glucoside coniferin, which Tiemann and Haarmann[7] have shown yields glucose and coniferyl alcohol upon hydrolysis. The fact that lignin does not behave like a true unsaturated compound would speak against the Klason and Kürschner conception of the structure of lignin. Further, when lignin is heated with hydriodic acid as in the Zeisel determination of alkoxyl groups, methyl iodide only is given off. This has been definitely established in the case of spruce[8] and oat-hull[9] lignin. If lignin were structurally related to coniferyl alcohol or a derivative of coniferyl alcohol or were a polymer of coniferin, one ought to obtain a mixture of methyl iodide and ethyl iodide upon heating it with hydriodic acid. Tiemann and Haarmann[10] have shown that coniferyl alcohol when heated with hydriodic acid gives both methyl iodide and ethyl iodide, the latter resulting from a degradation of the pro-

[1] P. Klason, Svensk Kem. Tidskrift, 1897, p. 135; "Beitrag zur Kenntnis des chemischen Baues des Tannenholzlignins," *Chem. Zentralblatt*, 90, I, 92 (1919); "Über Lignin und Ligninreaktionen," *Ber. deut. chem. Ges.*, 53, 706 (1920); 'Beitrag zur Kenntnis der Konstitution des Fichtenholzlignins," *Ibid.*, 53, 1864 (1920); "Beitrag zur Konstitution des Fichtenholz-Lignins," *Ibid.*, 58, 375, 1761 (1925); *Ibid.*, 62, 2523 (1929); *Ibid.*, 63, 792, 1548, 1983 (1930).

[2] K. Kürschner, "Zur Chemie der Ligninköper," p. 141, published in F. B. Ahrens' "Sammlung Chemischer und Chemischtechnischer Vorträge," 28, Ferd. Enke, Stuttgart, 1926.

[3] K. Freudenberg, "Zur Kenntnis des Fichtenholz-Lignins," Sitzungsberichte d. Heidelberger akad. d. Wissenschaften (*Math.-Naturwissenschaft*), 1928, Abhandlung, 19; K. Freudenberg, H. Zocher and W. Dürr, "Weitere Versuche mit Lignin," *Ber. deut. chem. Ges.*, 62, 1814 (1929).

[4] R. Willstätter and L. Kalb, "Über die Reduktion von Lignin und von kohlenhydraten mit Jodwasserstoffsaure und Phosphor," *Ber. deut. chem. Ges.*, 55, 2637 (1922).

[5] K. G. Jonas, "Das Problem des Lignins," Wochenbl. f. Papierfabrikation 56, No. 24A, 83 (1925).

[6] J. Marcusson, "Die Struktur der Huminsäuren und Kohlen," *Z. angew. Chem.*, 34, 437 (1921); *Ibid.*, 35, 165 (1922); *Ibid.*, 36, 42 (1923); *Ber. deut. chem. Ges.*, 58, 869 (1925).

[7] F. Tiemann and W. Haarmann, "Über das coniferin und seine Unwandlung in das aromatische Princip. der Vanille," *Ber. deut. Chem. Ges.*, 7, 608 (1874); F. Tiemann, "Zur Kenntnis des Glieder der Protocatechureihe," *Ber. deut. Chem. Ges.*, 11, 659 (1878).

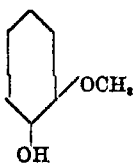
[8] E. Hägglund and B. Sundroos, "Zur Kenntniss Alkoxylgruppen des Holzes und des Lignins von Fichte," *Biochem. Zeitsch.*, 146, 221 (1924).

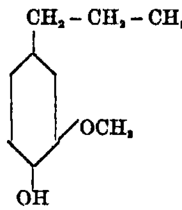
[9] M. Phillips, "The Chemistry of Lignin. IV. Lignin from Oat Hulls," *J. Am. Chem. Soc.*, 52, 793 (1930).

[10] Ref. 7.

pylene side chain. The conception of Freudenberg[11] that lignin is made up of vanilyl and piperonyl components, the union taking place through the hydroxyl group of the vanilyl constituent, although more in harmony with the experimental facts, is still open to objection in that the assumption is made that there are no free phenolic hydroxyl groups in lignin. Klason[12] has recently shown that in the case of lignin sulphonic acid, free phenolic hydroxyl groups are present. Furthermore, the evidence offered by Freudenberg[13] in favor of the presence of a methylene oxide group in lignin is by no means convincing.

In a paper recently presented by the writer before the Cincinnati meeting of the American Chemical Society, it was reported that when lignin was distilled with zinc dust at 400° C. in an atmosphere of hydrogen, an oil was obtained which amounted to 16 per cent. of the weight of the lignin used. Approximately, 55 per cent. of the oil was phenolic in character, and in this fraction guaiacol (III) was definitely identified. In continuing this line of investigation, another fraction has now been isolated from the phenolic portion of the oil. This fraction distilled over at 203 to 215° C. The 3,5-dinitrobenzoyl derivative of this was prepared, and after repeated crystallizations from ligroin and 95 per cent. ethanol, a crystalline substance, was obtained which melted sharply at 116.8° C. (cor.). This melting point corresponded exactly to that of the 3,5-dinitrobenzoyl derivative prepared from a pure specimen of normal propyl guaiacol (IV) (1,N. Propyl-3-methoxy-4-hydroxybenzene). When the two compounds were mixed


Guaiacol III


N. Propyl Guaiacol IV

the resulting mixture was also found to melt at 116.8° C. (cor.). The identity of these substances was further confirmed by the optical properties[14] of the crystals.

The isolation of guaiacol and n-propyl guaiacol as degradation products of lignin is believed to be of considerable significance from the standpoint of the constitution of lignin. It would appear, in all probability, that the two fundamental units in the structure of lignin are guaiacol and n-propyl guaiacol, the latter having the hydrogen atoms in the n-propyl side chain substituted by alcoholic hydroxyl groups. Just how the union takes place is, of course, not known, but probably through the n-propyl side chain in such a manner that leaves most of the phenolic hydroxyl groups free.

To account for the well-known reaction of lignin with bisulphites, it is not necessary to assume, as some investigators have done, the presence of an unsaturated bond in this complex, but can be explained according to Fuchs[15] on the basis that the phenolic nuclei may behave in their tautomeric form and, therefore, as unsaturated cyclic ketones.

This conception of the structure of lignin is in complete harmony with all the known facts as to its chemical behavior, and points the way toward a more complete understanding of its complex constitution.

MAX PHILLIPS

CONTRIBUTION FROM THE COLOR AND FARM WASTE DIVISION, BUREAU OF CHEMISTRY AND SOILS, U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

BOOKS RECEIVED

CURTMAN, LOUIS J. *Qualitative Chemical Analysis.* Pp. x + 539. 41 figures. Macmillan. $4.00.

EAST, EDWARD M., Editor. *Biology in Human Affairs.* Pp. xi + 399. Whittlesey House, McGraw-Hill. $3.50.

EMMONS, WILLIAM H. *Geology of Petroleum.* Pp. xi + 736. 433 figures. McGraw-Hill. $6.00.

HILL, A. V. *Adventures in Biophysics.* Pp. ix + 162. Illustrated. University of Pennsylvania Press. $3.00.

HOLMES, HARRY N. *Introductory College Chemistry.* Revised edition. Pp. viii + 550. 153 figures. Macmillan. $3.25.

MOTT-SMITH, MORTON. *This Mechanical World.* Pp. xvi + 233. 45 figures. Illustrated by Emil Kosa, Jr. Appleton. $2.00.

NEWSHOLME, SIR ARTHUR. *International Studies on the Relation Between the Private and Official Practice of Medicine with Special Reference to the Prevention of Disease;* Conducted for the Milbank Memorial Fund. Volume I: The Netherlands, Scandinavia, Germany, Austria, Switzerland. Pp. 245. Williams and Wilkins.

NEWTON, SIR ISAAC. *Opticks:* A Treatise of the Reflections, Refractions, Inflections and Colours of Light. Reprinted from the fourth edition. Pp. xxviii + 414. Illustrated. Whittlesey House, McGraw-Hill. $2.50.

SANDERS, J. EDWARD. *Safety and Health in Organized Camps.* Pp. viii + 133. National Bureau of Casualty and Surety Underwriters.

SPINNEY, LOUIS B. *A Text-book of Physics.* Fourth edition. Pp. xiii + 679. 422 figures. Macmillan. $3.75.

TISSERANT, R. P. CHARLES. *Essai sur la grammaire Banda.* Pp. 185. Institut d'Ethnologie, Paris. 45 francs.

TÔHOKU IMPERIAL UNIVERSITY. *Science Reports.* First series: Mathematics, Physics and Chemistry. Volume XX, No. 1: Pp. 196. Illustrated. Maruzen Company, Tokyo.

11 Ref. 3-b.

12 P. Klason, "Beiträge zur Konstitution des Fichtenholz Lignins," *Ber. deut. chem. Ges.*, 63, 792 (1930).

13 K. Freudenberg and M. Harder, "Formaldehyd als Spaltsück des Lignins," *Ber. deut. chem. Ges.*, 60, 581 (1927).

14 The optical properties of the crystals were determined by G. L. Keenan of the Food and Drug Administration of this Department.

15 W. Fuchs, "Uber Lignin und den Sulfit-Kochprozess," *Ber. Deut. chem. Ges.*, 54, 484 (1921).

SCIENCE

VOL. 73 FRIDAY, MAY 29, 1931 No. 1900

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE GENETIC VIEW-POINT[1]

By Dr. ALBERT F. BLAKESLEE

DEPARTMENT OF GENETICS, CARNEGIE INSTITUTION OF WASHINGTON

$$(A+\frac{hD}{2})\cdot(Z-\frac{hD}{3})$$

THAT I am a retiring president to-night is not my fault. I tried not to do it. I suggested to your secretary that in the future the president of the society make his retiring address the year after he presides and offered to forego or postpone my retiring address this year to set the scheme in operation. Your secretary refused to permit this innovation. (The American Naturalists, I now realize, is one of those societies which is run by the secretary). "I have had trouble enough now," the secretary said, "in trying to explain why the society elected the president they did. If the president should hang over another year before he retired, I should have either to remember the old excuses or to invent new ones. If I had my way," he said, "the formalities of the society would be confined to one day at the annual meeting. Let the president be elected and clothe himself with the insignia of his office in the morning, preside in the afternoon, and retire in the evening, at the Naturalists' dinner. The rest of the year the society can best do without a president altogether, while the secretary runs the society with the aid of his stenographer."

The secretary's arguments were hard to combat. So I tried next to obtain a substitute, an eminent foreign biologist who happened to be on a lecture tour in this country. This suggestion of a substitute met with the immediate (and I might say enthusiastic) approval of the secretary. All seemed working out to the welfare of the society as well as to the pleasure of the secretary, when I received a letter from my

[1] Presidential address delivered at the annual dinner of the American Society of Naturalists, Cleveland, Ohio, January 1, 1931.

substitute calling off his substitution. The secretary was helpful, as ever. He sent me a list of past presidents' addresses and offered fatherly advice: "Don't talk too much about your own work, but use it as a point of departure. Follow the trends of your predecessors." I have tried to comply with this admonition.

The reason for my title is two-fold. In the first place, it was necessary to send in a title, in response to the secretary's telegram, before it was possible to decide upon a subject for discussion. In the second place, it seemed desirable to follow the cryptic trend started by my immediate predecessor, if only to confirm the law of geologic evolution that too great departure from the normal may lead to extinction of the line. I may be sharing the thoughts of an armored dinosaur, if he had any thoughts at being the last of his line.

The last president took as his title "Kim Kurmah." He *said* it was Sanskrit and meant "Where are we at?" I am still skeptical as to what Kim Kurmahs really are. They sound to me more like a fermented health drink made from mares' milk and consumed in the Caucasus. Just to confirm a suspicion, I should like all those who looked up in the dictionary to see what the real meaning was of Kim Kurmah to please raise the right hand. No one raised a hand and no one here, therefore, looked up the meaning of these cabalistic words. Since Dr. Parker is not present to explain how he found his title last year, we may assume that he got the words only by hearsay. My simple experiment to-night with the members of the American Naturalists is encouraging to the present speaker. It shows what a retiring president of the American Naturalists can get away with when his audience knows he is actually retiring.

Now *my* title to-night is relatively simple. Its purpose was not to conceal thought but to develop thought. Probably many of you have already worked out its meaning as I had to do. As the secretary suggested, the formula is based upon Datura (D), the haploid Datura number of chromosomes (hD) is twelve, hD over 2 is therefore 6. If we remember our alphabet we will see that A plus 6 brings us to G. Similarly, Z minus hD over 3 means the subtraction of 4 from Z or the letter V. It will be seen that the formula $(A + \frac{hD}{2}) \cdot (Z - \frac{hD}{3})$ has thus given us the initials G.V. Since there are approximately 7,500 words beginning with the letter G and approximately 3,000 beginning with the letter V in Webster's unabridged dictionary, the initials G.V. could stand for any one of some 23,000,000 combinations. The announced topic, therefore, gave a rather wide choice of subject for discussion. If one were to use foreign words such as Sanskrit, the choice would be still greater [especially if one attributed meanings to such Sanskrit words without looking them up in the dictionary as the last president may have done]. In seeking two words to fit these initials I confined myself, however, to the English language. I tried to find a single word which would represent the most important concept in scientific research. This I believe I have found in the word "view-point." As a geneticist, I might reasonably be expected to touch upon genetic aspects. And the letters G.V. easily resolve themselves into the title "Genetic View-Point." In arriving at our subject for discussion we have used mathematics in the way in which we feel mathematics should be used in biology, not to lend an air of erudition nor as an end in itself, but as a means to an end.

It need hardly be argued that the mere accumulation of facts is of little value in science except as they are organized and contribute to new view-points. A species new to science, or a new 3 to 1 ratio, of itself has little interest to advanced workers. Loose sand and unrelated facts are of equal value in the construction of a concrete building and in the erection of an edifice of science. View-points may be good or bad, may be based upon a firm foundation of interrelated facts or upon assumptions and speculative analogy. In any case our view-points consciously or unconsciously determine the direction of our research and color the interpretation of our results. The establishing of fruitful view-points, and not the amassing of facts, is the goal of advanced research.

Evolution and the concepts of genetics form two major view-points of biology. The evolutionary view-point dates its birth from the publication of the "Origin of Species"—by general agreement the most influential book of the nineteenth century. The evolutionary view-point has not only revolutionized our ideas regarding the origin of species and given a meaning to a mass of facts in biology, but it has also influenced other phases of human thought. At its birth, it was at once realized that acceptance of the evolutionary view-point would render impossible a literal interpretation of the scriptures. It was at once bitterly combatted, therefore, by those theologians who were unable to adjust themselves to laying the emphasis upon the spiritual rather than upon the mechanistic values of religion.

The genetic view-point is almost wholly a twentieth century product, although the progeny test—*i.e.*, determining the genetic constitution of individuals from the character of their offspring, was developed chiefly in the nineteenth century. Mendelism was born, strictly speaking, in the nineteenth century, but the infant's birth cry attracted no attention. The child was kept in suspended animation for some 35

years, until 1900, when it was independently rediscovered by three botanists; Correns, deVries and Tschermak and taken out of cold storage. For this second birth, Bateson assumed the office of godfather and gave Mendelism and related subjects the name of "genetics." In the first decade of the twentieth century deVries gave us the mutation theory and another botanist, Johannsen, gave us the pure line theory. In the second decade, the banana fly was discovered as an object of investigation, and genetics became no longer chiefly a botanical activity.

The growth of the genetic view-point is too recent to need recounting in detail. It may be profitable, however, to compare it for a moment with that of the evolutionary view-point. We may use the progeny test of ideas and note the influence of these two view-points upon the direction of research. The new ideas of evolution stimulated observation and speculation and broadened the field of vision. It apparently did not increase experimentation. Darwin, to be sure, was a good botanical experimenter, but his disciples as a class did not follow this part of his example. Genetics on the other hand was born of experimentation and has made experimentation the basis and final test of hypothesis. It has thus limited speculation and narrowed the field of view.

It will be profitable to the biologist to know more of both these points of view. The study of evolution should, and I believe will, become experimental. Geneticists should take more account of the observations of those who have become familiar with plants and animals in nature, past and present. Life as we know it to-day is the resultant of a continuing series of experiments on a grand scale. They offer a challenge which the geneticist can not long continue to decline. The problem is a task for joint attack by workers with different view-points. An example is offered by taxonomy and genetics. These two fields appear to be separated at present by a fence of mutual distrust and misunderstanding. The taxonomist seems to think that the conditions of a genetics experiment are entirely artificial, and hence conclusions drawn from them have no relation to what exists in nature. Plants and animals under cultivation are not good species and hence not to be considered seriously by the taxonomist. I have been told, for example, that since the jimson weed was only a weed and not known in the wild, it was not a species; that I ought to study some real species from nature. Apparently the Datura follows too closely the pig, the cow and the plough of man. The taxonomist believes further that the characters shuffled so glibly by the geneticist are of trivial significance, with little or no influence upon survival in nature; and that taxonomic recognition of such genetic characters would render classification of plants and animals an impossibly unwieldy task.

The geneticist believes that the mere classification of the plants and animals of the world has reached the point of diminishing returns; that a "species new to science" has even less interest than the discovery of a new gene, since the latter may be put to work as a tester in helping to solve some of the problems in nature, while the new species may only help to swell the size of our taxonomic card catalogue. The geneticist accuses the taxonomist, among other faults, of lacking interest in the evolution of the forms he studies and of using trivial traits in his classification, which often shows little superiority to the Linnean system, so far as bringing out evolutionary relationships is concerned. The taxonomist is also accused of not caring whether the effects which he classifies are primarily genetic or primarily modifications brought about by the environment. In other words, the taxonomist is felt to lack both the evolutionary and the genetic view-points. These complaints from the two fields are admittedly extreme and only partially justified. It is a matter of congratulation that the fence between them has begun to be broken down in places. Taxonomists are known who have brought under cultivation the plants they were monographing, albeit not with the entire approval of their taxonomic colleagues. And geneticists have been known to study in nature the species with which they were carrying on genetic experiments and have even consulted the dead specimens in a herbarium.

Let us compare for a moment the effects of the view-points of evolution and of genetics upon the average individual, our much-quoted friend, the man in the street. The opposition of the public to evolution was immediate, violent, and the end is not yet. It would seem that the evolutionary view-point had deeply stirred our friend in the street. An analysis of the situation renders it evident that there is no natural opposition to the evolutionary view-point as such. The agitation which the theory has aroused was due almost entirely to its indirect effect upon established dogma of theology. Any other theory equally powerful in undermining the bulwarks of a mechanistic creed would have aroused as much opposition. That man has consanguinity with lower animals is not inherently abhorrent to the human mind as shown by the oriental belief of millions of people in the transmigration of souls and by the gods represented in Egyptian mythology as half animal in form. Man is most intently interested in the things of the present and the immediate future. In the year 1931 we can find plenty of men who would be willing to fight for their own wives and even some who would fight for other men's wives, but we would have difficulty in

finding a man so far visioned as to be willing to fight for the wife of an ancestor a thousand centuries ago or for the wife of a descendant a thousand centuries to come.

Our friend in the street might still believe that the first man was constructed from the dust of the ground or he might have been led to accept evolution. In the latter case he might believe with Gregory that man descended from an ape-like ancestor who cavorted only in trees, or he might prefer Osborn's doctrine that man arose from a similar ancestor with another name, who ran flat-footed on the desert sands. But his acceptance of the evolutionary view-point in itself would not materially alter his philosophy of every-day life. The genetic view-point offers a contrast to the view-point of evolution. Its central idea—Mendelism—was fathered by a monk without opposition from the church. Its growth to the present day has not engendered distrust or conflict in the public mind. And yet the genetic view-point has in it the power to change the attitude of our friend in the street in regard to well-nigh all his human relations.

Now what are the attitudes of mind which the genetic view-point is capable of changing? They are for the most part ingrained beliefs or assumptions which unconsciously color one's thinking. An example may be taken from a patriotic document familiar to every schoolboy. The Declaration of Independence says, "We hold these truths to be self-evident, that all men are created equal." This proposition, like many others assumed to be self-evident, is certainly not true. Despite what biology has taught us in the 150 years and more since the Declaration of Independence, its statement regarding the equality of all men at birth is probably an unconscious assumption in the minds of the majority of mankind, at least in regard to various aspects of man's nature. If questioned, our friend in the street might admit that the child of Japanese parents would probably not have the same stature and complexion as American children. And yet he probably would assume that, could we equalize the differences in education and other environmental influences to which any two children of a given race were subjected, the performance of the two children would be alike.

Those with genetic training may find it hard to realize the prevalence of the belief that men are born with equal potentialities. And yet this belief is not confined to the scientific layman. It is found among trained scientists and even among those who have a high standing as investigators of biological problems. In a review of a recent book on behaviorism, the New York *Times* quotes J. B. Watson as saying, "I would feel perfectly confident in the ultimately favorable outcome of careful upbringing of a healthy, well-formed baby born of a long line of crooks, murderers and thieves and prostitutes. I should like to go one step further now and say, 'Give me a dozen healthy infants, well formed, and my own specified world to bring them up in and I will guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant-chief and, yes, even beggar man and thief, regardless of his talents, penchants, tendencies, abilities, vocations and race of his ancestors.' "

Our quoted psychologist's declaration of independence of any genetic view-point is answered in a measure by critical experiments designed by another psychologist. The Seashore tests clearly show that humans do differ in their innate musical capacities and limitations. From our knowledge of genetics it is safe to say that in man no two individuals are exactly alike or ever have been; and, save for the possible exception of identical twins, probably no two individuals have ever been born with the same genetic constitution. Whatever politicians and others may say about the equality of mankind, the success of democracy is due to inequality, to leaders whom the majority learn to follow.

The genetic view-point regarding differences between individuals is opposed by current belief and by many tendencies in modern civilization. Uniformity seems to be the goal of conduct inculcated in the young. When young hopeful has shown a certain measure of originality in his behavior, grandmother is prone to lead him gently back to conformity with custom by the question, "Just think, little man, what would happen if everybody did as you have just done?" The logical reply would be, "What would happen if everyone were a grandmother?" Standardization has been a success in industry, but the genetic output of mankind—the production of children—will probably always remain a home industry rather than a matter of factory mass production. The products of this our literally infant industry need protection from the label of uniformity. Increased means of communication, movies and the radio, moreover, tend to make us look and act alike and are spoiling interesting experiments in different parts of the world in customs and ways of thinking.

An activity in which a thorough appreciation of the genetic view-point might materially alter present practice is our much-discussed educational system. Teachers expend their greatest efforts in attempting to raise low-grade students to average performance; but special capacities are inevitably pulled down toward mediocrity under a system in which uniformity is an unconscious ideal. From grades to graduate school, insufficient effort is directed toward discovering and developing exceptional talent. The road to a doctorate is prescribed and narrow. He

that attempteth to enter in by any other way, even though bearing ample fruits of scientific endeavor, is seldom rewarded. I have touched on these matters elsewhere. Suffice it to say that genetics teaches us the tremendous value of the exceptional individual in man as well as in economic plants and animals. How exceptional capacity may be early recognized and how it may be utilized in the furtherance of man's social and of his biologic evolution is a major problem of mankind which the genetic view-point has helped to emphasize.

The genetic view-point teaches that every biologic reaction is conditioned by the genetic constitution as well as by the external influences to which the individual is subjected. In other words, what every living being is and does is dependent upon the constantly interacting factors of heredity and environment. An appreciation of the relative value of these two factors would affect our ideals and practice in social and religious justice, in charity and education, and in all efforts for permanent human betterment. The genetic view-point attempts to evaluate the relative influence of heredity and environment but has been led by experience to look first for genetic causes of biological phenomena. Our friend on the street is prone to look first, if not exclusively, for environmental causes. The attitude of mind is seen in many biographies. The independent, self-reliant disposition of a national celebrity brought up in western pioneer surroundings, and the love of nature of a biologist raised in constant association with the wild life of the forests in Maine have been attributed to the direct effect of their environments. The fact that others in the same environment have not been similarly affected seems not to have been considered by the biographer, nor the possibility that the parents of their heroes may have been drawn to these environments by qualities of mind that have been transmitted to their offspring.

The blue grass region of Kentucky may grow taller men than other parts of the country, but their tallness in stature may have little to do with the blueness of the grass or other environmental peculiarities of the state. The real explanation may lie in the fact that the early settlers of this region came from the tallest racial stock in Europe, as Davenport has suggested. Anthropologists believe they have evidence that conditions in this country have increased stature and affected other anthropological measurements, thus bringing about changes in the physical nature of man in America. We have been told, for example, that less use of the jaws and muscles of mastication, due to better prepared food, is reducing the teeth, the jaws, the breadth, protrusion and massiveness of the face. Environment is known to have a direct influence upon individual development and thus might reasonably be expected to affect anthropological measurements. In such case, however, the effects would hardly be expected to be cumulative. The differences observed may conceivably be due to differences in genetic constitution between the two groups measured. The human species is tremendously heterogeneous even within a so-called race and it would be extremely difficult to be sure of securing two samples in which the differences in genetic constitution would be negligible, especially if the samples came from different countries or from different generations. In the latter case, age differences might be a source of error. In both cases a geneticist could think of possible genetic explanations. The genetic view-point would urge caution, therefore, in seeking first an environmental explanation for anthropological differences. Similar suggestions might be offered regarding most other phases of the study of man in which genetically controlled conditions are so difficult of attainment.

Twenty-five years ago I listened to a symposium before the British Association for the Advancement of Science, in which it was debated whether chromosomes had any connection with heredity. The passage of time has settled the question. A mechanism of heredity involving the chromosomes has been established; and the conclusion seems amply justified that any changes must be gotten into the chromosomes in order to be inherited. The genetic view-point, therefore, would place the burden of proof upon those who ignore the known mechanism in their attempts to influence the hereditary stream.

The belief is common, in one form or another, that an environmental stimulus is capable of calling forth an hereditary response similar to the original stimulus applied. A pregnant mother is chased by a turkey gobbler and her child is born with a red birthmark on the throat. The blemish is diagnosed as a result of maternal impressions. Beliefs such as this, which run counter to the established mechanisms of heredity, are called superstition if held by the man in the street. If held by a biologist, they are often called Lamarckism. In both cases they indicate an ignorance or neglect of established mechanisms.

The expectation that induced changes should resemble the stimuli which initiated them is *a priori* improbable and opposed to the known cases of induced mutations. Much of the belief in the inheritance of so-called "acquired characters" is the result of wishful thinking. One who believes, for example, that a man's college education will affect the mind of his newly born children may be led to realize that it is capacity to respond, and not the response itself, which is inherited. One who believes he has an example of environmentally induced somatic modifications affecting the germ-plasm should be forced to

prove that new factors for these changes have been gotten into the chromosomes. No such proof has yet been given for the inheritance of an "acquired character."

The pigmentation of races in the tropics, for example, has been considered an "acquired character" induced by the intense illumination, which has become inherited as a racial characteristic of tropical peoples. The differences in types of pigmentation in different races of man might have made a cautious student hesitant to propose the above explanation. Similar differences in pigmentation are found in man's nearest relatives, the anthropoid apes. Thus the chimpanzee has a pale skin and the gorilla has a black or negroid skin. Both live in the forests of equatorial Africa. Furthermore, pale pigmentation might even better be regarded as the more recent type, since dark skin pigment, at least that of the Negro, does not behave as a recessive character and recessives, so far as our experience goes, are more likely to be derived types. There is no critical evidence in support of the belief that the pigmentation of races is an example of the inheritance of an acquired character.

The evident adaptations of species to their surroundings naturally lead to the belief that in some way the environment has had a directive influence. Whether this has involved more than the elimination of the unadapted through natural selection is still an open question. But the rôle of natural selection still remains a major problem awaiting adequate experimental investigation. Experimentation has given us a mechanism of inheritance. Is it too much to hope that experimentation can give us also the mechanisms of evolution? Genetics has been largely confined to a study of inheritance. The origin of the term admits of a broader definition. The future geneticist may concern himself more with the problems of evolution. Evolution then may properly be considered a subdivision of genetics.

The mechanism of Mendelian inheritance, with unit factors dealt out to us by chance, may be an unpleasant idea to some. But whether we like it or not, it is an idea which is influencing our views of life. Responsibility and freedom of will, for example, have been much argued in the past. In future discussions of these subjects, philosophers must take into account the mechanism of inheritance.

You may be wondering why in such an assemblage as this I have been discussing the biological sins in attitude of the man in the street. My reason is that, so far as the genetic view-point is concerned, the man in the street is often a biologist. By biologist I mean one engaged in the study of any form of life, especially in this case including man. It has seemed less personal to discuss the man in the street, although beliefs differing only in form are held by our non-genetic brethren in biology.

Perhaps the most common evidence of lack of genetic view-point among biologists is shown in their use of biological controls. Many fail to realize that plants and animals which look alike may differ markedly in genetic constitution and hence in their individual response to selected stimuli. To take examples from our own experience, Miss Satina has shown that races of bread moulds (Mucors) which are indistinguishable in appearance, even when examined microscopically, may differ in sex, strength of sexual activity and in their biochemical reactions.

In the jimson weed we have what we call cryptic races. They resemble our standard line in all visible particulars, and even an examination of their chromosomes might reveal no differences. That they are unlike our normals, however, is shown, first, by the peculiarities in inheritance of certain genes, but only in plants with particular chromosomes extra; second, by modification of the morphology of certain extra chromosomal types when hybridized with them; third, by abnormal configurations of chromosomes (circles of four instead of pairs) in hybrids with normals; and also by other peculiarities of behavior under special conditions. Before the existence of these cryptic types was suspected, it was felt desirable to establish a purified race as a standard. We now have such a race, the result of 17 generations of selfing and once passing through a haploid. All our primary and secondary extra chromosomal types have been gotten into this standard line, and their peculiarities can now be compared without the haunting fear that other factors than extra chromosomes may be influencing their behavior. Our own results, therefore, are closely comparable among themselves. The results might not be comparable, however, if experiments were carried on with races from different countries even if these races were highly inbred. We now know enough of the distribution of cryptic types in nature to be practically certain that an investigator of wild strains of Datura from Europe would be unable to duplicate all the results obtained from our standard line of this species.

Comparable living material is as important to the biologist for accurate experimentation as is purified chemical material to the chemist. Species in nature or commercial varieties when subjected to careful analysis have been found to be a mixture of diverse races, or otherwise genetically heterogeneous. Many investigators without genetic experience, however, are satisfied with sunflowers grown from a packet of commercial seed or with guinea-pigs purchased from the trade for their biological material, although they may be insistent upon the purity of their chemical reagents. Such too common failure to realize that the

living reagents may differ in their physiological responses has often led to conflicting results of different investigators, as well as of a single investigator, when working with the same species.

When results are easily evaluated, over-refinement in an experiment may be a waste of time, but it is well to recognize the sources of error before making short cuts in methods. It will probably be safer in starting an elaborate experiment to use pure chemicals and comparable biological material.

In plants, genetically comparable material may be secured by using cuttings of a single individual, or relatively pure races may be obtained by selfing for a few generations. With animals having biparental reproduction, purification of races is difficult. By continued brother to sister matings, however, strains can be isolated incomparably better adapted to experimental purposes than the ordinary run of laboratory animals. Such inbreeding of mice, for example, has led to the isolation of races differing markedly in susceptibility to inoculated and to spontaneous tumors. Medical investigators as a class seem only just beginning to realize the value of the genetic view-point. Perhaps of more value to the medical profession than another endowment for cancer research would be an international institute for the breeding of purified races of rats, mice, guinea-pigs and other biological test material. Investigators in different parts of the world might then have available a source of comparable living reagents.

In man, our worst experimental animal, such purification is impractical. Identical twins we have suggested as the only source of really comparable material in the human race, but their use for experiments is limited. In human experiments, in which controls are most needed, it is most difficult to get comparable material. In human problems, therefore, dependence is unavoidedly placed upon the dangerous methods of random sampling and statistical treatment and conclusions are often drawn from data which, with forms better adapted to experimentation, would be considered inadequate. It should not be forgotten, however, that the mathematical reliability of conclusions bears no relation to the difficulty in securing adequate data.

We have given an all too inadequate presentation of the need of the genetic view-point in the street and in the biological laboratory, and have pointed out how common has been its lack even in high places. We have reached the point in our discussion at which to inquire what we are going to do about it.

In research, a blending of view-points in cooperative investigations suggests itself as a remedy. The geneticist may find he receives more than he contributes in such cooperation.

For the oncoming generation we can strive to strengthen the genetic education. It seems difficult for one to come to think in terms of the genetic view-point without actually following the shuffling of genes in breeding experiments. We may not succeed in convincing our educational administrators that laboratory work is as much needed in genetics as in chemistry. We can at any rate encourage the growing of Drosophila and to this end might bring political pressure to bear to lower the duty on bananas.

In stressing the shortcomings in other fields of labor, my voice may sound like the voice of a preacher. I have tried, however, to follow the lines of least resistance and at the same time of greatest efficiency. We know more about the faults of others than of ourselves. If we were able to view ourselves from a distance and there were unlimited time, we might relate some of our own sins and give advice to geneticists. The pleasure of giving advice to geneticists, however, can more profitably be left to a later speaker who is not a geneticist. Advice, you know, is a commodity which it is more blessed to give than to receive.

In conclusion, we feel justified in believing the genetic view-point, with all that it implies, is the most important biological contribution of the nineteenth and twentieth centuries. It is still broadening its scope and influence, but even now it has within it the power to change profoundly our philosophy of everyday life. In any program for the salvation of the future of the human race, it will be necessary to have the genetic view-point somewhere in the formula.

AN OPTIMISTIC VIEW OF THE EVOLUTION OF THE SCIENCES[1]

By Dr. VIRGIL F. PAYNE
PROFESSOR OF CHEMISTRY, TRANSYLVANIA COLLEGE

THE American Association for the Advancement of Science has fifteen sections devoted to the activities of specific science or related groups. Science has been defined as accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws. In this sense a specific science is any

[1] Address of the president of the Kentucky Academy of Science read on April 3 at a joint meeting of the Ohio, Indiana and Kentucky Academies.

branch or department of systematized knowledge considered as a distinct field of investigation or object of study. If we accept this definition the fifteen sections are in reality science sections. In fact, standard dictionaries define all the fields of knowledge represented as sciences except history, and the association itself has designated section "L," historical and philological sciences. This broad view of science and the sciences is the one accepted for the present purpose.

While many fields of knowledge are accepted as sciences, only physics, chemistry, biology, psychology, sociology and economics will be taken as illustrations. For our purpose physics is defined as that branch of science dealing with those phenomena of inanimate matter involving no change in chemical composition. From the view-point of the complexity of original subject-matter physics may be considered the simplest of the sciences mentioned. No doubt, due to this simplicity and the availability of its materials, physics was one of the first bodies of knowledge to be accepted as a science.

Chemistry is defined as the science that treats of the composition of substances, and the transformations which they undergo. Since chemistry involves transformations in the inanimate matter of physics, it is to that extent a more involved science. It was as a consequence accepted later as a field of knowledge worthy of the efforts of scholars and as a suitable subject for students. In the sense that art relates to something to be done in contrast to science as something to be known, the art period of alchemy made its contribution to modern chemistry. Likewise the periods of iatrochemistry and of phlogiston made contributions. However, we trace our modern chemistry back more definitely to the work of Lavoisier.

Biology is the science of life; the branch of knowledge which treats of organisms. As such, biology involves more intricate and elusive subject-matter than do physics and chemistry. On account of the difficulties involved in establishing controls and in accumulating tested knowledge the workers in the simpler sciences are prone at times to deny the biologist unqualified admission to the science fraternity. The value of biology and the perseverance and caution of its workers have, however, long since resulted in the establishment of a science of biology with its various branches.

Psychology is the science of mind; systematic knowledge and investigation of the genesis, powers and functions of mind. Just as biology is considered more involved than physics or chemistry so in turn psychology in its pursuit of knowledge of the consciousness of life has had more difficulty in finding its place as a science. The techniques involved in the study of psychology differ so markedly from those associated with the measuring instruments of physics, the balance in chemistry, and the microscope in biology that we should not be surprised. The fact that the psychologists are so divided by their theories has been a factor in their tardy acceptance. In spite of the reluctance of the older sciences, psychology has now been generally accepted.

Sociology is defined as the science of the constitution, phenomena and development of society. Sociology involves the complexities of life and consciousness with all the added difficulties in adjustment attending the interplay of conscious life in groups of various sizes. Many thinkers maintain that sociology can never be a science but since the time of Comte the claim for this right has made progress. The greatest difficulty individual scientists have is in the recognition of the worth of techniques of scientists in other fields. The statistical method of sociology with its use of the expression, probability, is almost too much for the older sciences.

Economics is the science that investigates the conditions and laws affecting the production, distribution, and consumption of wealth. This science is included not so much because of a logical place in the order of complexity of the other sciences named but more on account of its timely interest. We may judge from the present condition of the world that there is no true science of economics or that the best economists are not trusted and such scientific knowledge as exists is not practiced. This conclusion is obvious in spite of the slowly accumulated and tested knowledge since the writings of Adam Smith in 1776.

It is difficult to divide the sciences into sub-groups. We may call physics and chemistry physical sciences, and the others considered biological and social sciences. For the present purpose the older and more commonly accepted sciences of physics, chemistry and biology will be referred to as exact or material sciences, and, the newer and more reluctantly accepted, psychology, sociology and economics will be referred to as social sciences.

A mixture of extravagant praise and equally bitter condemnation has been heaped upon these and other material sciences. These sciences have been commended as making possible the material advantages of our present civilization. They have been blamed for contributing to an increasing disregard for the accepted social values. This machine age has had to face the anomalous charge of bringing hunger to many because of an over-production of food and of depriving many people of the very benefits of the age because too many of these benefits had been produced. It seems only fair to assume that the material sciences have been working effectively and have the power to do much more. They have indeed made possible our material civilization and, in fact, also

they make possible the very best social civilization. By them all the necessities and the luxuries are produced with an average individual expenditure of time that allows leisure for transforming the social studies into real sciences.

Our hope then seems to lie not in decreased interest in the material sciences but in using the leisure afforded by them in perfecting the social sciences. We now have much more tested knowledge in psychology, sociology and economics than we are using. We may reasonably hope that intensive, continued research in these fields, equivalent to that given in the past to the material sciences, may produce comparable results. Confidence in the work of the social scientists should result in the establishment of a social order respected and observed by an improved race of people. The economist and sociologist may expect to assume the burden of so organizing society that it would be impossible for over-production and want to exist simultaneously on the earth. Under such an economic and social system everyone may be profitably engaged as producer, investigator or subject of investigation. In our present system a severe migraine headache has qualified one man for profitable employment as a research subject. The social scientists are ready to assume their responsibilities and the next step is to train a generation that will turn as readily to them for guidance in these fields as the present generation depends on the physicist, the chemist and the biologist. Because of the sobering influence of such a responsibility we need have little fear of extravagance of promise or action.

The accepted sciences may do well to drop their double standard of viewing one group of sciences as exact and another as inexact. They should lead in the unqualified acceptance and encouragement of the social sciences. The physicist and chemist deal with 25,000,000,000,000,000,000 molecules per cubic centimeter of gas or 33,667,000,000,000,000,000,000 molecules of water per cubic centimeter. They do not face all the hazards the sociologist encounters in individual differences of human beings in a small community. The physicist and chemist, in particular, should be very tolerant of the efforts of the sociologist to determine the statistical significance of the different phenomena observed in small populations.

If our social order is to come under the dominant influence of science it seems worth while to consider what will happen to some of the arts that have concerned themselves with society. The oldest and most highly respected of these arts is religion. We have in this art to deal with elements of belief, faith and prejudice which seem diametrically opposed to the principles of caution, control and tests in science. However, in 1873 F. Max Muller had written an "Introduction to the Science of Religion." We may hope that religion may eventually be saved for a scientific age by the acceptance of the method of science.

What attitude are we to take concerning the conflicts of theories in the social sciences? We must follow the plan we have always used in the older sciences. The conflicts must serve as a stimulus to more intense and exhaustive research. The conflicting doctrines in science have almost invariably resulted in bitterness—also a great amount of experimental study. It is not possible to condemn too heartily the attitude of the chemist who would get the camel through the eye of the needle by dissolving him in nitric acid and then using a squirt gun.

Finally, a word of caution seems appropriate. Should we displace entirely an old established art such as religion because it involves some unscientific principles and practices? No more should we discard this art than that of pottery-making while we are developing a science of ceramics. The vessel of the pottery craftsman may be crude. It may contain unnecessary ingredients; some very valuable ingredients may have been omitted, but if it makes a satisfactory container it has served a useful purpose. Certainly if perishable and necessary goods are being produced the industry should not be closed over a long period for repairs and remodelling. It has long been held that religion is such an enterprise. Furthermore it is worth while to be reminded again that our oldest sciences such as chemistry and astronomy were preceded by the arts, alchemy and astrology. When we feel most certain that we have found the final solution we may well recall Oliver Cromwell's exhortation, "My brethren, by the bowels of Christ I beseech you, bethink you that you may be mistaken."

OBITUARY

RAOUL GAUTIER

Professor Raoul Gautier died at his home in Geneva, Switzerland, on April 19, 1931. He was vice-president of the International Geodetic Association of the International Geodetic and Geophysical Union. At the end of 1927, when he retired from the position which he had so long filled as director of the Astronomical Observatory of Geneva, Switzerland, the Conseil d'Etat of the Canton of Geneva conferred on him the titles of honorary professor of the University of Geneva and of honorary director of the Observatory. Previous to his retirement he

had filled the chair of astronomy and meteorology of the faculty of sciences of the University of Geneva.

For many years Professor Gautier was a member of the permanent commission of the old International Geodetic Association, attended several of its triennial assemblies and took a prominent part in its affairs. When the world war began and little support was given to the association by its adhering members, Professor Gautier was largely instrumental in forming what was termed the "Association Géodesique reduite entre Etats Neutres" and served as its president for several years. It was mainly due to his foresight and scientific efforts that anything at all was accomplished in geodesy, in an international sense. Through his efforts the results obtained at the variation of latitude stations at Ukiah, California, Mizusawa, Japan, and Carloforte, Italy, were computed and made available for the use of astronomers. After the war, when the International Geodetic and Geophysical Union was created, he transferred to the section of geodesy (name changed in 1930 to International Geodetic Association) of that union the functions and property rights of the old association and of the reduced association which had functioned during the war. He later became vice-president of the section (association).

In addition to his other duties, Professor Gautier was for many years president of the Swiss Geodetic Commission. He was a powerful influence for several decades among geodesists of the world and they, as well as the astronomers, mourn his death. His keen intellect and scientific attainments aroused the admiration of all those who knew him, either personally or through correspondence, and his charming personality endeared him to his many friends.

His health had not been good for the last few years, especially since the death of Mme. Gautier on January 4, 1927. After his retirement, on December 31, 1927, he was not actively engaged on astronomical or geodetic work, but he maintained until the very last his strong interest in those matters, especially such as were of an international character. He made several trips to the south of France in search of health, but most of his time was spent in Geneva. Two sons and two daughters survive him: Colonel Paul Gautier, of Bogota, Colombia; M. Max Gautier, Mme. William E. Rappard and Mme. Marcel DuPasquier, of Geneva.

William Bowie

U. S. Coast and Geodetic Survey

WHITMAN HOWARD JORDAN

The death of Dr. W. H. Jordan, director of the State Experiment Station at Geneva from 1896 to 1921, occurred at his home in Orono, Maine, on May 8, following a prolonged period of ill health. Born in Raymond, Maine, on October 27, 1851, Dr. Jordan received his early training at the University of Maine, graduating from that institution in 1875.

In 1878 he entered the employ of the Connecticut Agricultural Experiment Station as an assistant chemist, and from that date on his professional career and personal interests to the time of his death were intimately associated with experiment station work. He returned to Maine in 1879 to serve for one year as an instructor in chemistry, and then went to the Pennsylvania State College as professor of agricultural chemistry in the college and as agricultural chemist in the experiment station. While at State College he laid out a series of soil plats for experimental purposes, the fiftieth anniversary of which is to be celebrated in June, when Dr. Jordan was to have been the guest of honor.

In 1885 he was called back to Maine to become director of the Experiment Station at Orono, where he served for eleven years. In 1896 he entered upon his work at Geneva as director of the New York State Experiment Station where he was to serve for twenty-five years and to attain an international reputation as an investigator and administrator.

Dr. Jordan was the author of books on human and animal nutrition and of numerous experiment station publications and special articles. He was also an effective speaker, and while director of the Geneva Station was frequently called upon by farm organizations and others to address them on the work of the station and on other topics. His conception of the function of the experiment station as a research institution and his insistence that the station be allowed to perform its work unhampered has undoubtedly had a profound influence on the contributions that the station has made to the agriculture of the state.

A. A. HIMWICH

On April 18th occurred the death, in New York City, of A. A. Himwich, M.D., at the age of sixty-nine years. Dr. Himwich was one of the most beloved of the Russian intelligentsia, coming here among the first of the great immigration of 1881.

Dr. Himwich was a physician of recognized ability and continued his medical work at Berlin with Professors Klemperer and Kraus. At New York University he received the B.S. degree in 1886; M.D. in 1887 and M.S. in 1891. There Dr. Himwich was a beloved student of Chancellor McCracken, Professor Stevenson and Professor Herring. Post-graduate work was continued at Columbia under Professors Woodward and Pupin and at the Johns Hopkins under Professors Mall, Osler and Martin.

Dr. Himwich was deeply interested in the later developments of mathematics and physics and particularly in relativity. He was a fellow of the American Association for the Advancement of Science, and

a member of many scientific organizations, including the American Mathematical Society and the American Medical Association. For thirty years he was a visiting physician of the Beth Israel Hospital, of which he was one of the founders; and also a founder, and later the director, of the Educational League where college courses were given to men and women. Dr. Himwich was known by men in many fields and was active in progressive movements.

Important work was done by him unostentatiously, quietly and modestly. He was an idealist and well-loved, shedding light in his path. He was unobtrusively learned and continually busy with his studies and researches. Though always surrounded by books, he never shut himself from life and was ever ready to take part in useful social endeavors. His wife and two sons survive him: Dr. Rose I. Himwich, Dr. Harold E. Himwich, associate professor of physiology at Yale University, and Mr. Alfred W. Himwich, a teacher in the New York Public Schools.

M. D.

RECENT DEATHS

DR. ALDRED SCOTT WARTHIN, since 1903 professor of pathology and director of the Pathological Laboratory at the University of Michigan, died suddenly on May 23, at the age of sixty-five years.

EDWARD DEAN ADAMS, in large measure responsible for the electrical installations at Niagara Falls and other engineering projects, active in engineering and scientific organizations, died on May 23, at the age of eighty-five years.

PROFESSOR A. ZIMMERMAN, for the past nine years instructor in the department of chemistry of the University of Kentucky, died on May 21, at the age of thirty-five years.

PROFESSOR ALFRED WEGENER, the German meteorological explorer, chief of the German Scientific Expedition exploring central Greenland, has been found frozen to death. Dr. Wegener was fifty years of age.

SCIENTIFIC EVENTS

THE THIRD INTERNATIONAL CONFERENCE ON BITUMINOUS COAL

AN impressive group of scientists from Europe will take part in the Third International Conference on Bituminous Coal which will be held at the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, from November 16 to 21. Germany, England and France will send the largest delegations.

New developments in fuel technology and utilization will be explained and discussed by the foremost authorities. Those interested in coal research may hear such German authorities as Dr. Friedrich Bergius, of Heidelberg, whose process for the hydrogenation of coal has been purchased by the I. G. Farbenindustrie; Professor Franz Fischer, of the Kaiser-Wilhelm Institute for coal research, whose process for forming liquid hydrocarbons from gases has been widely discussed, and Professor Ernst Berl, of Darmstadt.

Among the English members, contributions will be made by Professor William A. Bone, of the Imperial College of Science and Technology, London; Dr. Cecil Lander, director of the Fuel Research Board, London, who has done much work on low temperature carbonization and the utilization of coal generally, and Dr. R. Lessing, consulting chemist, also of London.

France will be represented by a distinguished group. Among them will be Professors Mailhe and Camille Matignon, of the Sorbonne, Paris; M. André Kling, director of the Municipal Laboratory of Paris, who is known for his work in producing motor spirits from coal by hydrogenation. Other European nations will send their foremost scientists to the Pittsburgh congress.

The tentative program outlined by the conference committee places emphasis on the economic side of the coal industry. A discussion of the competition between coal, petroleum and natural gas will have an important place in the program. Recent large scale hydroelectric developments will come in for discussion when water power is compared with steam produced with coal as a source of energy. The future of coal as the source of power for locomotives and steamships will be forecast by scientific authorities in these fields. A report of the cost of transporting energy in various forms promises to bring forth a discussion on pipe lines for natural gas and petroleum, the coal car and superpower transmission.

Reports on the actual status of low temperature carbonization throughout the world have been planned for the third meeting. Other subjects that are sure to find a place on the program are the origin of coal, problems of combustion, gasification and liquefaction of coal, smoke elimination and preparation of coal for the market.

In preparing for the third international meeting, Dr. Thomas S. Baker, president of the Carnegie Institute of Technology and organizer of the congresses, spent several months in Europe, reviewing the coal situation. Invitations were extended at that time by Dr. Baker to a group of fuel technologists in addition to those named above, and a large attendance is assured.

In America a prominent group of men of affairs will assist with the conference. This group, the official advisory board, is composed of Mr. James A. Farrell, president of the United States Steel Corporation; Mr. John Hays Hammond, prominent mining engineer; Mr. Samuel Insull, public utilities magnate; Mr. Frank B. Jewett, president of the Bell Telephone Laboratories, Inc.; the Honorable A. W. Mellon, Secretary of the Treasury; Mr. F. A. Merrick, president of the Westinghouse Electric and Manufacturing Company; Mr. Auguste G. Pratt, president of the Babcock and Wilcox Company; Mr. H. B. Rust, president of the Koppers Company; Mr. Matthew S. Sloan, president of the New York Edison Company; Mr. Gerard Swope, president of the General Electric Company, and Mr. W. C. Teagle, president of the Standard Oil Company of New Jersey.

THE LABORATORY OF ANTHROPOLOGY AT SANTA FE, NEW MEXICO

AWARD of thirteen all-expense scholarships has been made for the Laboratory of Anthropology's third season of training in anthropologic field-method.

The scholarships are designed to enable properly qualified graduate students to supplement, by practical work in the field, the classroom and laboratory instruction which they receive at the universities. Recipients of scholarships take part in the current investigations of experienced research men; they have opportunity to become familiar with the use of modern field-methods for the collection of data; they gain experience in the interpretation of these data and in their application to anthropological problems, specific and general. It is planned to offer, year by year, scholarships for work in various branches of anthropology in various geographical areas.

Scholarships for this season have been awarded for training in archeology, under the direction of Dr. Frank H. H. Roberts, Jr., of the Bureau of American Ethnology, and will pursue field work in excavation and study of a Pueblo ruin near Houck, Arizona. Scholars in ethnology will work among the Mescalero-Apache of southeastern New Mexico, under the direction of Dr. Ruth F. Benedict, of Columbia University. Scholars in anthropology will work with Dr. Harry L. Shapiro, of the American Museum of Natural History, and will pursue their studies in a selected French-Canadian village.

The scholarships are open only to graduate students who are fitting themselves for professional careers in anthropology and who must be registered in university departments granting higher degrees in anthropology, and must be recommended for appointment by the chairman or head of the department in which they are registered.

The committee on scholarships received applications from forty graduate students who had been recommended for consideration by their departmental head. Awards for the nine week period of training during 1931 are as follows:

Physical Anthropology:

Carolyn M. Adler, Columbia University.
James M. Andrews, Harvard University.
Helen L. Dawson, Washington University (St. Louis).
Marcus S. Goldstein, George Washington University.

Alternates

Morris Titiev, Harvard University (first alternate).
William H. Sassaman, University of Chicago (second alternate).

Archeology:

Ralph D. Brown, University of Minnesota.
Solon T. Kimball, Harvard University.
Dale S. King, University of Denver.
Carl F. Miller, University of Arizona.

Alternates

Catherine L. Serrem, Radcliffe College (first alternate).
William J. Winter, University of Arizona (second alternate).

Ethnology:

Jules H. Blumensohn, Columbia University.
Regina Flannery, Catholic University, Washington, D. C.
John P. Gillin, Harvard University.
Morris E. Opler, University of Chicago.
Sol Tax, University of Wisconsin.

Alternates

Clarence W. Dupertuis, Harvard University (first alternate).
Rose Cantor, University of Pennsylvania (second alternate).

The members of the committee on scholarships are: Neil M. Judd, curator of American archeology, U. S. National Museum; A. M. Tozzer, professor of anthropology, Harvard University; E. Sapir, professor of anthropology and general linguistics, University of Chicago, *chairman*.

The Laboratory of Anthropology has been enabled to carry forth this field instruction in anthropologic field-method by reason of two grants in amount of $15,000 and $60,000, respectively, from the Rockefeller Foundation. These funds, with contributions from other sources, cover the expenses of such instruction from the period of commencement in 1929 to 1934 inclusive.

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

THE second and final meeting of the Board of National Research Fellowships in the Biological Sciences for the award of 1931–32 appointments was held in

Washington on April 30 and May 1. In addition to the twelve reappointments and seventeen new appointments voted at the February meeting, seventeen further reappointments and twenty first appointments were made at the current meeting, as follows:

REAPPOINTMENTS

For domestic study: G. W. Beadle, agriculture; Ralph L. Beals, anthropology; P. J. Daughenbaugh, biochemistry; R. K. Enders, zoology; Paul E. Fields, psychology; F. L. Howard, botany; A. W. Kozelka, zoology; W. E. Lammerts, botany; C. E. Leese, zoology; R. B. Loucks, psychology; Helen Mar Miller, zoology; C. W. Watson, forestry; G. R. Wendt, psychology.

For study abroad: J. P. Greenstein, biochemistry; David B. Hand, biochemistry; C. H. McConnell, zoology; C. V. Smythe, biochemistry.

NEW APPOINTMENTS

For domestic study: M. P. Backus, botany; Abram G. Bayroff, psychology; C. R. Carpenter, psychology; A. E. Clarke, agriculture; Kenneth D. Doak, agriculture; C. R. Garvey, psychology; W. F. Hahnert, zoology; A. Hollander, biochemistry; T. L. Jahn, zoology; Barbara McClintock, botany; Florence E. Meier, botany; W. O. Nelson, zoology; Donald M. Purdy, psychology; A. E. Saeger, botany; Burch H. Schneider, agriculture; George D. Snell, zoology; J. M. Valentine, zoology; J. Volkmann, psychology.

For study abroad: Marc A. Graubard, zoology; E. L. Proebsting, agriculture.

In accordance with the plan of rotation in membership of the board the terms of the following members expire on June 30 of this year: H. H. Bartlett, botany; F. R. Lillie, zoology, and E. L. Thorndike, psychology. To complete the membership in these three fields, the National Research Council has appointed E. W. Sinnott, of Columbia University, for botany; M. H. Jacobs, of the University of Pennsylvania, for zoology, and Madison Bentley, of Cornell University, for psychology.

Meetings for 1932–33 awards will be held approximately early in February and either in April or May of next year. More definite announcement concerning these will be made in SCIENCE in the fall. Information and application forms may be obtained at any time from the Secretary, Board of National Research Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

FRANK R. LILLIE, *Chairman*
Board of National Research Fellowships in the Biological Sciences

THE DIAMOND JUBILEE OF THE ST. LOUIS ACADEMY OF SCIENCE

THE St. Louis Academy of Science celebrated on April 14 and 15 the diamond jubilee of its foundation. The event was featured by a lecture delivered on April 14 by Dr. Robert G. Aitken, director of the Lick Observatory, who described some of the recent advances in astronomy. On the following evening the jubilee dinner was held.

The academy, which has lately been affiliated with the American Association for the Advancement of Science, was founded on March 10, 1856, under the presidency of George Engelmann, the well-known botanist. Its purpose was the practice and encouragement of research in various branches of science, the building up of a scientific library and the formation of a museum. From the beginning it formed a forum for the presentation and subsequent publication of researches in botany, geology, natural history, physics, chemistry, etc. Many of the original papers of George Engelmann, Hiram A. Prout, Benjamin F. Shumard, George S. Swallow, F. E. Nipher and William Trelease are found in the twenty-six volumes of the *Proceedings* which have been published. The academy maintains exchanges with a large number of the learned academies and societies of Europe and America.

Some of the present officers of the academy are Dr. Alfred F. Satterthwait, of the U. S. Bureau of Entomology, *president;* Dean Walter E. McCourt and John J. Lichter, *vice-presidents;* Dean Alexander S. Langsdorf, of Washington University, *recording secretary;* James I. Shannon, St. Louis University, *corresponding secretary;* Albert Kuntz, St. Louis University, *librarian,* and J. D. Robertson, *treasurer.*

THE AMERICAN ACADEMY OF ARTS AND SCIENCES

AT the annual meeting of the American Academy of Arts and Sciences, held at 28 Newbury Street, Boston, on May 13, the following fellows were elected in the scientific classes:

CLASS I

Mathematical and Physical Sciences

Charles Harold Berry, Harvard University.
Karl Taylor Compton, the Massachusetts Institute of Technology.
George Russell Harrison, the Massachusetts Institute of Technology.
George Leonard Hosmer, the Massachusetts Institute of Technology.
Robert Bruce Lindsay, Brown University.
William Albert Noyes, Jr., Brown University.
Otto Oldenberg, Harvard University.
George Rutledge, the Massachusetts Institute of Technology.

CLASS II

Natural and Physiological Sciences

George Blumer, Yale University.
William Bosworth Castle, Harvard Medical School.

Eugene Floyd Du Bois, Cornell Medical College.
William King Gregory, the American Museum of Natural History.
George Francis McEwen, the Scripps Institution, La Jolla, California.
Charles Alfred Weatherby, the Gray Herbarium, Harvard University.

Foreign Honorary Members

Ludwig Diels, Berlin.
August Krogh, Copenhagen.
Karl Willy Wagner, Berlin.

The following officers of the academy were elected:

President, Jeremiah D. M. Ford.
Vice-president for Class I, Harry M. Goodwin.
Vice-president for Class II, Walter B. Cannon.
Vice-president for Class III, Edwin F. Gay.
Vice-president for Class IV, Charles B. Gulick.
Corresponding Secretary, Tenney L. Davis.
Recording Secretary, Walter E. Clark.
Treasurer, Ingersoll Bowditch.
Librarian, Alfred C. Lane.
Editor, Herbert V. Neal.

On the recommendation of the Rumford Committee, the academy voted to award the Rumford Medals to Dr. Karl T. Compton, for his researches in thermionics and spectroscopy.

SCIENTIFIC NOTES AND NEWS

AT a dinner given by the Wistar Institute of Anatomy at the Hotel Bellevue-Stratford, Philadelphia, Dr. Simon H. Gage, emeritus professor of histology and embryology at Cornell University, was the guest of honor, on the occasion of his eightieth birthday on May 20.

DR. HARLOW SHAPLEY, director of the Harvard College Observatory, has been elected an honorary foreign member of the Royal Swedish Physiographic Society of Lund, and a foreign correspondent of the Royal Lombard Institute of Science and Letters.

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution, has been elected an honorary member of the Société Orthologique et Mammalogique de France.

PROFESSOR ALBERT EINSTEIN, preliminary to delivering the third and last of his series of Rhodes Memorial Lectures at the University of Oxford on May 23, received from the university the degree of doctor of science.

THE University of Belfast will confer the honorary doctorate of science on Dr. Joseph Barcroft, professor of physiology at the University of Cambridge.

THE doctorate of laws was conferred by Queen's University, Canada, on May 6, on Dr. H. T. Güssow, Dominion botanist and chief of the Phytopathological Service of the Dominion of Canada. Dr. Güssow has also been elected a fellow of the Royal Society of Canada.

DR. PAUL ANDERSON, dean of the School of Engineering of the University of Kentucky, was the guest of honor at the annual spring dinner of the Kentucky Society in New York.

DR. CHARLES LANE POOR will retire from the chair of celestial mechanics at Columbia University at the close of the academic year. Dr. Poor's permanent address will be Dering Harbor, Greenport, Maine.

DR. MAURICE B. VISSCHER, professor of physiology and pharmacology at the University of Southern California, has been appointed professor of physiology at the University of Illinois College of Medicine in Chicago. He will occupy the chair formerly held by the late Professor George P. Dreyer. The new laboratories for physiology will be ready for occupancy during the summer.

DR. BORIS A. BAKHMETEFF, who was undersecretary of state and later ambassador to the United States during the Kerensky régime in Russia, has been appointed professor of civil engineering at Columbia University. He has been a consulting engineer in New York since 1922.

DR. RALPH D. BENNETT, who for the past year has been assisting Professor Arthur H. Compton in preparing for a series of experiments on cosmic rays, has been appointed associate professor of electrical engineering at the Massachusetts Institute of Technology.

DR. LOUIS B. SLICHTER has been appointed associate professor in the department of geology at the Massachusetts Institute of Technology. Dr. Slichter is a graduate of the University of Wisconsin, where he received the degree of doctor of philosophy in mathematical physics. During the war, he carried on research on the detection of submarines, and later formed, together with Dr. Max Mason, now president of the Rockefeller Foundation, a geophysical prospecting company for the location of mineral deposits. During the past year he has been engaged in the mathematical study of scientific geophysical problems at the California Institute of Technology.

PROFESSOR HENRI FEHR, head of the department of mathematics at the University of Geneva, has been appointed rector of the university. He is known to Americans and to the mathematical and educational world at large as the editor of *l'Enseignement Mathématique*, and as secretary of the International Commission on the Teaching of Mathematics, not only the present one, but the one that was founded in 1908. He has held a professorship in the University of Geneva since 1900 and was twice dean of the faculty of science.

DR. ERNEST WILLIAM HOBSON, since 1910 Sadlerian professor of pure mathematics at the University of Cambridge, will retire on September 3.

PROFESSOR KURT WEGENER, formerly head of the Spitzbergen Observatory, will succeed as leader of the German Scientific Expedition his brother, Professor Alfred Wegener, who died in Greenland.

DR. R. F. MEHL, superintendent of the division of physical metallurgy of the Naval Research Laboratory, has been appointed assistant director of research of the American Rolling Mill Company, Middletown, Ohio. He will be in charge of the physical science department of the Armco laboratories, and will take up his new responsibilities on September 1. He has been one of the research consultants for this company for the past eighteen months.

EARLY in May Dr. William Beebe sailed for Bermuda with a staff of nine. This will be the fourteenth expedition of the department of tropical research of the New York Zoological Society and the third Bermuda Oceanographic Expedition. Study of the fish of the shallow waters and deep sea trawling will be carried on from Nonsuch Island as a base along the lines of work of the last two years. Particular attention will be paid to the bottom fauna a mile and a half down. An attempt will be made in September in the bathysphere to reach a depth of half a mile beneath the surface.

DR. ROBERT HEGNER, professor of protozoology in the Johns Hopkins University School of Hygiene and Public Health, accompanied by two of his students, Dr. Carl Johnson and Dr. Robert Stabler, sailed recently for Panama where they will spend the summer studying Amoebiasis at the Gorgas Memorial Laboratory.

THE American research expedition headed by Professor George G. Simpson arrived in Buenos Aires on May 20 from Patagonia after seven months' study of paleontological fauna on behalf of the American Museum of Natural History. Professor Simpson will continue his studies in the La Plata Museum.

DEAN RICHARD G. TYLER, of the College of Engineering at the University of Washington, will spend the coming summer in Europe, where he will inspect hydraulic laboratory installations in Germany and England. Dean Tyler, whose particular field is sanitary engineering, will also study water purification methods being developed by continental engineers.

THROUGH a cooperative arrangement between the Physikalische-Technische Reichsanstalt and the U. S. Bureau of Standards, an exchange of personnel has been arranged for the purpose of promoting work on fundamental standards. Dr. F. Henning, of the Physikalische-Technische Reichsanstalt, is studying at the Bureau of Standards the proposal of the bureau that the emission from a black body at the freezing point of platinum be adopted as the primary standard of light. Dr. G. W. Vinal, of the staff of the Bureau of Standards, is proceeding to the Reichsanstalt to engage in intercomparisons of the national standards of electromotive force and in work on the improvement of standard cells.

DR. HEINRICH WIELAND, professor of organic chemistry at the Technical School at Munich, winner of the Nobel Prize in chemistry in 1930, was a recent lecturer at the University of Washington. Under the auspices of the Washington Chapter of Sigma Xi, Professor Wieland discussed recent researches in biological oxidations. He is touring the United States, accompanied by Mrs. Wieland.

DR. F. G. BANTING, head of the department of medical research in the Banting Institute of the University of Toronto, spoke to students and faculty members of the medical school of the University of Michigan on May 8 on "The History of Insulin."

PROFESSOR H. D. SMYTH, of Princeton University, spoke at the Bartol Laboratory of the Franklin Institute on April 22 on "The Band Spectrum of Carbon Dioxide."

DR. G. H. PARKER, director of the Zoological Laboratory of Harvard University, delivered the following series of lectures, during the week of May 4, at the University of Minnesota under the auspices of the department of zoology: "The Nervous System and Its Effectors," "Chromatophores and Other Effectors in Relation to Secretion." "The Significance of Secretion in Sense Organs and Central Nervous Organs," and "The Passage of Sperms and Eggs through the Oviducts of the Higher Vertebrates."

THE College of Medicine of the University of Illinois Chapter of Sigma Xi held a meeting for the initiation of new members on May 20. At this meeting Dr. F. R. Moulton, past national president and member of the National Executive Council, pre-

sented greetings from the national organization. Greetings from Northwestern Chapter were presented by Dr. F. D. Barker, *president* of the chapter, and from the University of Chicago Chapter by Dr. E. S. Bastin, *vice-president* of the chapter. The scientific discourse was given by Dr. O. F. Kampmeier on "The Origin and Development of the Human Thoracic Duct."

AT the annual meeting of the Boston Society of Natural History, held on May 6, the following officers were elected for 1931–1932: *President,* Charles H. Taylor; *Vice-presidents,* Nathaniel T. Kidder, Glover M. Allen and William M. Wheeler; *Secretary,* Clinton V. MacCoy; *Treasurer,* Augustus P. Loring, Jr.; *Trustees,* Thomas Barbour, Joseph A. Cushman, William L. W. Field, Laurence B. Fletcher, Frederic H. Kennard and John C. Phillips. At the same meeting the annual Walker Prizes in Natural History, offered for the best memoir on any subject in the field of general zoology, were awarded to Arthur Svihla, of the State College of Washington, for his memoir entitled "A Comparative Life History of the Mice of the Genus *Peromyscus,*" and to Mr. Tze-tuan Chen, of the University of Pennsylvania, for his memoir on the "Sympathetic Nervous System of an Annelid."

A MEETING of the Acoustical Society of America was held on May 4 and 5 in Camden, New Jersey, in the auditorium of the RCA Victor Company. At this meeting the following officers were elected for the new year: *President,* Dayton C. Miller, Case School of Applied Science; *Vice-president,* C. W. Hewlett, General Electric Company; *Secretary,* Wallace Waterfall, The Celotex Company, Chicago; *Treasurer,* E. E. Free, New York City; *Executive Council,* F. R. Watson, University of Illinois; G. W. Stewart, The State University of Iowa; Vern O. Knudsen, University of California at Los Angeles, E. W. Kellogg, RCA Victor Company, Inc., Camden, New Jersey, and H. D. Arnold, Bell Telephone Laboratories, New York City. The next meeting of the society is to be held on November 30 and December 1 in Cleveland, Ohio, at the Case School of Applied Science.

THE fourteenth annual meeting of the Royal Society of Canada was held from May 20 to 22. Dr. Charles Camsell, deputy minister of mines of the Dominion, delivered, as president of the society, an address on Canada's position in the mineral situation of the British Empire. Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory at Victoria, British Columbia, gave a popular lecture on "The Structure and Motions of the Galaxy."

IT is stated in *Nature* that at the annual election of the Royal Philosophical Society of Glasgow, on March 25, the following officers were elected; *President,* Professor W. R. Scott; *Vice-president,* Dr. J. W. French; *Honorary Treasurer,* Sir John Mann; *Honorary Librarian,* Dr. J. Knight; *Honorary Auditors,* Mr. John J. D. Hourston and Mr. James A. French; *Acting Secretary,* Dr. James M. Macaulay. During the session, Sir Donald MacAlister, chancellor of the University of Glasgow; Sir C. V. Raman, professor of physics in the University of Calcutta, and Professor F. O. Bower, emeritus professor of botany in the University of Glasgow, were elected honorary members of the society.

A GENERAL meeting of the members of the Royal Institution was held on May 4, Sir Robert Robertson, treasurer and vice-president, in the chair. Sir Joseph Thomson was reelected honorary professor of natural philosophy, and Lord Rutherford of Nelson was reelected professor of natural philosophy.

IT is announced officially that the next International Mathematical Congress will be held the first week in September, 1932, at Zurich, Switzerland. The committee on organization consists of Professor A. Fueter, of the University of Zurich, *president;* Professors H. Fehr, rector of the University of Geneva, and M. Plancherel, of the Ecole polytechnique fédérale, Zurich, *vice-presidents;* and Professors F. Gonseth, of the Ecole polytechnique fédérale, and A. Speiser, of the University of Zurich, *secretaries.* The secretaries may be addressed at the Séminaire de mathématiques, Université, Zurich. It will be recalled that the first of these international mathematical congresses was held in Zurich in 1897.

THE Second General Assembly of the International Union for the Scientific Investigation of Population Problems will meet in London from June 15 to 19 of this year. The delegates of the American National Committee who will attend this meeting are: Dr. Raymond Pearl, president of the union, the Johns Hopkins University; Dr. Louis I. Dublin, chairman of the American National Committee, Metropolitan Life Insurance Company; Dr. Alfred J. Lotka, secretary-treasurer, American National Committee, Metropolitan Life Insurance Company; Dr. John Black, chairman, Commission 1, Population and Food Supply, Investigation of Population Problems of the International Union, Harvard University; Professor Robert E. Chaddock, Columbia University; Professor Henry Pratt Fairchild, New York University; Professor James W. Glover, president, Teachers Insurance and Annuity Plan; Dr. George W. Kosmak, editor, *American Journal of Obstetrics and Gynecology;* Mr. Frank W. Notestein, Milbank Memorial Fund; Dr. L. J. Reed, of the Johns Hopkins University, and Dr. P. K. Whelpton, of the Scripps Foun-

dation for Research in Population Problems. Seven of these delegates are sailing on the *Rotterdam* on June 6.

THE Paris correspondent of Science Service reports that the prize offered by the International Committee of the Red Cross at Geneva for a reagent to detect small amounts of deadly mustard gas in the air has not been awarded. The jury of chemists found none of the submitted reagents satisfactory. According to the terms of the contest, the reagent should have been able to detect with certainty less than one grain of the gas in about one quart of air. The amount of the prize was 10,000 Swiss francs, about $2,000. The contest closed last December and the jury has since then been considering the reagents submitted with their methods of use. These were known to the jury only by number, the names of the authors being kept separately. All the methods and reagents were examined in detail. Nine were eliminated at the first examination. The remaining four were made the subject of control experiments. The results were not sufficiently conclusive and the jury decided it could not award the prize offered by the committee. The jury consisted of the following: Professor G. Urbain, of the Sorbonne, director of the Chemical Institute of the University of Paris, president; Professor F. Haber, member of the Berlin Academy; Professor F. Swarts, of the University of Ghent, member of the Belgian Royal Academy of Sciences; Sir William Pope, professor at Cambridge University, member of the British Royal Society; Dr. H. Zangger, professor at the University of Zurich, director of the Institute of Legal Medicine of Zurich, and Professor Demolis, technical adviser of the International Committee of the Red Cross.

THE National Geographic Society has presented to the National Museum of Washington the zoological specimens collected by the expedition to the jungle frontier between Brazil and Venezuela which was headed by Mr. Ernest G. Holt.

THE Division of Horticultural Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, has established at Seattle, Washington, a laboratory to be devoted to research on the freezing preservation of fruits and vegetables.

THE economic depression has been reflected in the hospitals throughout the country, it appears from the American Medical Association's annual survey of hospital service in the United States, as quoted by Science Service. Although the hospitals did more work during 1930 than the previous year, the increase came entirely in charitable institutions. The association states in the current issue of its journal that "While governmental and other charitable hospitals were burdened with an unusually large number of patients, those that serve pay patients generally suffered a decrease in patronage." During 1930, the number of beds in all types of hospitals increased from 907,133 to 955,869. This increase of 48,736 beds does not include bassinets, of which there were 1,645 more during 1930 than the year before. Hospitals for nervous and mental patients continued to grow. The capacity of these institutions increased from 414,386 to 437,919. Over nine tenths of the beds available in these hospitals were occupied during 1930, while less than two thirds of the available beds in general hospitals were occupied. Outpatient services of hospitals had a tremendous growth, both in the number of such departments and in their use. The greatest number of new departments were organized in western states, but the greatest rate of growth was in the South Atlantic states. The type of service given in hospitals has also shown a steady improvement during recent years, as shown by the increased number of x-ray and physical therapy departments and laboratories.

DISCUSSION

THE PROGRAM OF THE UNIVERSITY ASSOCIATION FOR THE STUDY OF CALENDAR REFORM

THE University Association for the Study of Calendar Reform has been organized by a group who believe that any real alteration of the calendar is some years in the future, as only a small minority in scientific, educational and business circles is showing interest, and these persons do not agree on what alterations are desirable. The members of this association believe, therefore, that persons interested should investigate methods of eliminating as many as possible of the alleged defects of the present calendar without waiting for the proposed overhauling. In other words they suggest that we clear the ground for future work by finding out which of the troubles charged are real calendar defects, and which can be remedied by changing present methods.

According to calendar reform organizations (SCIENCE, January 30, 1931, page 118), "the three undisputed defects of the present calendar are: Unequal months; changing of week-day names for monthly dates; drifting dates for Easter and other church festivals." The months vary in length from twenty-eight to thirty-one days. The number of

working days is even more variable because of holidays and the five-Sunday and four-Sunday months, and in addition a correction for seasonal differences must be applied in business studies. The "changing of week-day names for monthly dates" means that business in months of one year can not be compared with that of corresponding months in the year following without corrections; and that a schedule of events made out for one year in month and day of month must be altered to fit the weeks of the following years. The present custom is to schedule recurring events as, for example, the Saturday following the fourth Monday of April; but in spite of much time spent in devising such rules, there are many conflicts, mistakes and worries. The other "undisputed defect" is a religious custom, not a calendar defect. The dates for these church festivals drift because they are not set by our present calendar. Easter commemorates the Resurrection of Jesus, and the Christian Church has seen fit to use, not only the date as given in the Scriptural narrative, but also the lunar months in use in Palestine at that time. Whether or not this rule is to be changed is a question for the churches to decide, and it should be discussed in religious, rather than scientific periodicals. Some wage earners who are paid weekly have difficulty meeting heavy monthly bills, and some persons on a monthly salary have trouble with weekly bills. Other difficulties have been charged against the calendar, but most are associated with the four we have listed.

Let us now consider, as we have suggested, the possibilities of improvement without waiting for an international overhauling of the world's calendar. First: For annually recurring events the period of recurrence is a year, and such events should, therefore, be assigned a certain week of the year, instead of a certain week of the month. The fifty-one (sometimes fifty-two) complete weeks of the year are indicated on calendars and almanacs in general use, and numbers for these weeks can easily be written on the margin of the office calendar. If the schedule for the following year is made out, assigning to each annually recurring event the same week and day of week as for this year, these events fall in exactly the same order, and the relation of each to all others in the annual schedule is unchanged. In this way a few interested business men can make out a permanent schedule for nearly all important events in their community without the average citizen knowing anything about it. Later, if a sufficient number become interested, calendars with the numbers for the weeks printed to the left of Sunday should be put in circulation. The general public probably would, at first, pay no more attention to these numbers than to those indicating the day of the year now printed on so many calendars; but the more intelligent would soon begin using them for such purposes as figuring the number of weeks for which wages must be paid on a certain job, or the number of weeks to the close of the school year. If the calendars carry the suggestion that the number for the week be used in scheduling recurring events, an increasing number of schedules would be so made out, and the date confusion to which calendar reformers refer would be practically eliminated. A business firm operating on this plan, which has been called the *numbered weeks* system, would, year after year, be scheduling practically the same events for a given week, and the sales for a group of weeks in one year could be directly compared with the same group in other years, thus avoiding another difficulty. Since many firms are now using an auxiliary calendar of groups of weeks to avoid the unequal months, the suggestion is evidently practical. Easter is a religious question, as we have pointed out, and need not be considered here. The last difficulty—that of wage earners on a weekly basis with heavy monthly expense items, is avoided by billing on each pay day, which is now recognized as a good business principle.

The preceding brief discussion has of necessity touched on only a few points, but we hope it has been sufficient to suggest the program, in line with the experimental method of modern science, which the organizers of the association now favor. The officers are: *Joint Chairmen,* Roy C. Flickinger, University of Iowa, Iowa City; Jakob Kunz, University of Illinois, Urbana, and *Secretary-Treasurer,* C. C. Wylie, University of Iowa, Iowa City. Correspondence is invited.

C. C. WYLIE

UNIVERSITY OF IOWA

PLURAL FRACTIONS AND OTHER FRACTIONS

UNDER the title of "Plural Fractions," Dr. C. E. Waters in the February 20 issue disapproves of the practice, common in scientific journals, of using the plural of the unit named when the number is a fraction; examples are .04 grams and .5 atmospheres. His arguments are good from his point of view, but there is another way of looking at the question.

Dr. Waters says that in reading 4/100 gram one naturally says "four one-hundredths (of a) gram," and he objects to writing .04 grams. But if instead of supplying *of a,* we supply *measured in,* then the plural is required. In a table headed "potential, volts" or "wave length, Angstroms," one naturally supplies *measured in* where the comma is placed, and when this is done the heading seems a perfectly natural one even though the maximum potential recorded be −.825 volts.

Probably no one will deny that it is more convenient to adopt the plural form exclusively for such writing, for one may then head a table "potential, volts" without committing an error when some of the figures are fractions or are negative. Another advantage is in the use of abbreviations; one may write *g* for *grams*, and not bother about *g* or *gm* for *gram* and *gs* or *gms* for *grams*. We should be pleased, then, if a justification has been found for the almost universal practice of using the plural form exclusively.

Dr. Waters objects to "occurs at every 2×10^3 collision" on the grounds that one would not write "at every two collision." Now we can easily write "at every second collision" or at "every fiftieth collision," because there is a well-known terminology for the small ordinal numbers, but for the large ones this is not true. Dr. Waters assumes that in this example 2×10^3 is used in its numeral sense: I prefer to take it in its ordinal sense. Should one write 7.2×10^4 *d* or 7.2×10^4 *th*? Either is awkward and apt to be misunderstood, so why not use 7.2×10^4 for either the ordinal or numeral sense when there can be no ambiguity? The same is being done with small numbers; we see a street sign marked "38 street" and read it "thirty-eighth street."

An offense worse than misusing singular and plural forms in naming units is not to use either one, so let us hope that no one will be so fearful of blundering in the singular and plural that he choose to omit any name whatever.

While on the subject of plurals I should like to mention the perplexing problem of forming the plural of symbols. In dealing with equations involving $x_1, x_2, x_3, \ldots$, when one wishes to speak of them collectively, it is probably easy enough to write "the x_i's in eq. (3)," but if these quantities had been denoted by $A'^2_1, A'^2_2, A'^2_3, \ldots$ or some other complicated symbols, plurals formed with the apostrophe and *s* would be clumsy. A practice that seems proper, is surely advantageous and deserves wider use is to omit any sign of plural form and simply write "the x_i (or A'^2_i) in eq. (3)." Many nouns do not add *s* or change in any way in the plural, so there is nothing peculiar in mathematical symbols behaving the same way. In some foreign languages the modifying article is different in its singular and plural forms and the mathematical writer profits by it. In English it seems best to use the symbol without change in the collective sense, and charge the offense, if there be any, to the deficiencies of our language.

W. EDWARDS DEMING

BUREAU OF CHEMISTRY AND SOILS,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

THE ACCUMULATION OF STRONG ELECTROLYTES IN LIVING CELLS

RECENT uncritical discussion[1,2,3] of the relative validity of the two hypotheses as to the mechanism of selective accumulation of ions by living cells merits rectification. We refer to the "molecular hypothesis" (Osterhout) and the "ionic exchange" hypothesis (Brooks).[4,5,6] Osterhout's criticism of the ionic exchange hypothesis is self-contradictory, illogical, or based upon distorted interpretation, and he does not discuss certain serious weaknesses of his own molecular hypothesis.

Specific details being incompatible with the space limitations of the present communication, attention is called to the following condensed comparison.

(1) No test permitting *experimental* discrimination between the two hypotheses has yet been applied. Experimental alteration of intra- or extra-cellular pH does not constitute such a test. Disagreement between observed and calculated rates of ion intake when the basic assumptions are changed in the middle of the calculation (*i.e.*, after numerical values for relative permeability to different ions are reached) proves nothing as to the relative validity of the two sets of assumptions.

(2) No non-aqueous solvents[7] have to my knowledge been shown to be more permeable to KOH than to NaOH, as apparently demanded by Osterhout's molecular hypothesis. On the other hand, divers artificial and natural membranes which are selectively permeable to cations do show such a difference as regards K^+ and Na^+, and so do many if not most living cells. Analogous anion permeable membranes resemble living cells in showing little differential permeability to different univalent anions. The ionic exchange hypothesis thus has well-established experimental analogs, which are entirely lacking for the molecular hypothesis, which has so far offered no rational explanation for the highly selective absorption of ions by living cells.

(3) The molecular hypothesis fails to explain why K in the form of KCl molecules does not pass out of the cells used by Osterhout faster than it goes in as KOH. Using Osterhout's formulations we deduce as necessary to his hypothesis the following assumptions:

a. That KCl is about 50,000,000 times more disso-

[1] W. J. V. Osterhout, *Jour. Gen. Physiol.* 14: 277, 1930.

[2] W. J. V. Osterhout, *loc. cit.*, 14: 285, 1930.

[3] A. G. Jacques and W. J. V. Osterhout, *loc. cit.*, 14: 301, 1930.

[4] S. C. Brooks, *Proc. Soc. Exp. Biol. Med.*, 27: 75, 1929.

[5] S. C. Brooks, *Protoplasma*, 8: 389, 1929.

[6] S. C. Brooks, In *Contributions* to Marine Biology, Stanford University, California, 1930.

[7] Exception being made of selectivity ion-permeable membranes which may be regarded either as porous solids or as non-aqueous solvents (see Brooks[6]).

ciated in aqueous solution than is KOH, or

b. That the diffusion constant of KOH in the hypothetical non-aqueous medium bounding the protoplasm is 50,000,000 times that of KCl, or

c. That the two factors combined account for the 50,000,000-fold difference.

Such assumptions would be purely *ad hoc* and without experimental basis or parallel.

(4) Until 2 and 3 above are satisfactorily explained the molecular hypothesis must be regarded as untenable.

The detailed answer to Osterhout's criticism and a fuller explanation of the above points will be published in another journal.

S. C. BROOKS

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF CALIFORNIA

A CURIOUS COLOR PHENOMENON

WHILE experimenting with an intermittently flashing neon discharge tube, the writer observed a phenomenon which may thus far have escaped being reported, if not observed, by others. He has demonstrated it to a number of persons, all of whom agree upon the description of what they perceive. Whether the effect is subjective or objective is not definitely established, but it appears to be purely objective.

A neon tube about 4 meters long, made of 8 mm glass tubing, is bent in the shape of a grid, so that a rectangular area 25 x 35 cm is covered by the parallel portions of the tube, which are spaced about 2 cm between centers. The tube is supported in a frame-like box, backed by a reflector, and covered in front by a ground glass panel. The illumination from the tube is somewhat diffused, but the shape of the tube is distinguishable through the ground glass. The tube is flashed by the high voltage from the secondary of a transformer, giving about 10,000 volts maximum when a direct current through the primary circuit is interrupted. A mechanical device is employed to make and break the primary at any desired frequency up to twenty-five per second.

At the upper frequencies, the light appears nearly continuous, the color being that which has become so familiar through the neon advertising sign. As the frequency is gradually decreased, flickering becomes pronounced at about twenty flashes per second, without change in color. The duration of the flash is very short, but its time has not been determined. If the observer looks directly at the ground glass when the frequency reaches twelve or ten flashes per second, there appear around the edges of the screen bright fringes of color—blue, green, bright red and yellow—colors quite different from the normal color of the tube. The interplay of colors becomes more striking as the frequency is further decreased. They shift and dance about, and at a frequency of about seven they flash and flicker over the entire illuminated screen, with the regular neon color predominating as a background. The colors observed are vivid and unmistakable. At a frequency of three or four flashes per second the varying colors disappear and only the characteristic neon color remains.

If an electric fan is set in operation in front of the "neon screen," and the frequency of flashing adjusted so that there is apparently slow rotation of the fan, the edges of the blades are outlined with the "dancing" colors. The colors observed do not appear in the lines of the spectrum.

A neon tube bent in the form of a flat spiral, and without a ground glass diffusing screen, has been found to give similar effects.

PAUL E. KLOPSTEG

CENTRAL SCIENTIFIC CO.,
CHICAGO, ILLINOIS

THE AUTO-TRACTION HYPOTHESIS OF CRUSTAL DYNAMICS AND MECHANICS

THE department of geology, University of Manitoba, has a paper in the press which presents a preliminary outline of an hypothesis of crustal dynamics and mechanics. It introduces the conception of a sheet-flow in the crust of the earth, similar to that in ice-sheets. It calls into play the translation of all available geological energy into the great forces that have effected the geological changes of the past and elucidates a mechanism that seems to throw new light on most of the major crustal phenomena.

The paper will be issued shortly in pamphlet form as a contribution from the department of geology, University of Manitoba, Winnipeg. Any one interested in the hypothesis may communicate with me at this address and a copy of the paper will be mailed as soon as it comes from the press.

J. S. DELURY

SCIENTIFIC BOOKS

Atlas Céleste. By E. DELPORTE. Cambridge University Press, London; Macmillan, New York, 1930.

LAST year Dr. Delporte, of the Royal Astronomical Observatory at Uccle, Belgium, set down new boundaries of the constellations as arcs of hour circles and parallels of declination. He did this work at the recommendation of the International Astronomical Union. Its successful completion was a remarkable example of international cooperation. This work

was accompanied by star charts on which the new boundaries were drawn.

It has been a happy idea to use these beautiful charts in the star atlas, which is the subject of the present review. The twenty-six charts covering the whole celestial sphere contain the stars brighter than magnitude 6.5. They are not overcrowded and the distinction between brighter and fainter stars is so well made that the appearance is unusually clear. The stars are drawn for equator and equinox of 1875.0 for the technical reason that the newly adopted boundaries were defined in this system. This led to the advantage that very little had to be changed in the southern hemisphere where Gould defined the boundaries.

The twenty-six charts are all printed on the right-hand pages. On the corresponding left-hand pages the positions of all stars, brighter than magnitude 4.5, are listed for 1875.0 and 1925.0. This feature makes it possible to obtain the positions at any other date with great ease. The magnitudes and spectral types of the stars are also given. On the same page we find separate lists of the more important variable stars, double stars, star clusters and nebulae.

The description of the boundaries is not given in this atlas. For these one has to use Dr. Delporte's "Délimitation Scientific des Constellations" or Professor Schlesinger's "Bright Star Catalogue." In an appendix to the latter the new boundaries are listed in a different way, which is at the same time simpler and more efficient

Dr. Delporte's "Star Atlas" is a useful guide at the telescope at a very moderate price. It is highly recommended to every student, amateur and professional astronomer.

The fact that the book has a French title ought not to frighten any one, as the text consists exclusively of astronomical symbols of an international character.

Dirk Brouwer

Yale University Observatory

Lingnan Science Journal (continuation of *Lingnaam Agricultural Review*), Vol. VII and Nos. 1 to 4 of Vol. IX. Printed by the Commercial Press, Ltd., Hongkong, 1931.

Unless one has made a careful and very recent study of Chinese affairs, and unless one knows China, one is apt to think of that country as in a state of disorganization that has lasted for years and that has disrupted government, commerce and education to an appalling degree. With a knowledge only of the newspaper headlines, and not taking into consideration the great size of that country and the rather primitive means of communication, one does not realize that life goes on uninterrupted in great regions, and that, while battles may be fought in an adjoining province and while banditry may exist in the next town but one, work is going on steadily in literally thousands of communities.

In this way they have been going on at Lingnan University. This institution, formerly known as Canton Christian College, has been in existence for forty-three years. Since the Boxer rebellion, it has been located on Honan Island. This is an island formed by two branches of the Pearl River and is about two and a half miles from Canton proper, communication being by boat. The university is a private institution, is non-denominational and coeducational. In 1928 a new Science Hall was built, having been financed by the Rockefeller Foundation and by Mrs. Willard Straight.

Volume VII of the *Science Journal* is the first of two volumes of the proceedings of a science conference held on the occasion of the formal opening of the new science building which is called Willard Straight Hall, on October 19, 1928. Volume VIII will appear shortly, including the rest of the proceedings of that conference. Four parts of Volume IX, with miscellaneous contents, have been published in advance of the appearance of Volume VIII.

The proceedings of the formal opening seem to have been of very great interest. Volume VII covers more than 800 pages and carries several plates. The contents are extremely diverse in character. The larger number of papers, however, relate to biology. Contributions had been invited from naturalists in different parts of the world, and the papers are therefore sound and important.

Volume IX shows that there is being published a journal that can not be ignored in scientific circles. The papers in Nos. 1 and 2 include among the subjects treated ornithology, entomology, botany, parasitology, chemistry, meteorology, forestry and anthropology. There is a department entitled "Books" that gives reviews of important volumes, and also a department of "Abstracts."

There is also a department headed "Scientific Notes" that bids fair to become of much importance. It contains short signed notes on differing topics, and the last number added to it a section entitled "General Notes."

Lingnan University is especially strong in scientific work, biology, chemistry and agriculture being emphasized. The journal is sent in exchange for several hundred scientific journals to various countries, and fits in with the plan of the university to establish one of the largest scientific libraries in China.

It is probably unnecessary to add that the journal is published in the English language. I am told by Dr. William E. Hoffman, the chief editor, that nearly

all the instruction in the college is given in this language.

To give an idea of the varied contents of the journal, I list as follows some of the titles of articles that appear in Nos. 1 and 2 of Volume 9: Lefever, Rufus H., "Summer Birds of Hongkong"; Takahashi, R., "Notes on Some Chinese Aphididae"; Tai, F. L., "Studies in Gymnosporangia on Juniperus Chinensis —I. Gymnosporangium Yamadae Miyabe"; Merrill, E. D., "A Third Supplementary List of Hainan Plants"; Werner, F., "Rana Leporipes, a New Species of Frog from South China, with Field Notes by R. Mell"; Wu, K., "A Study of the Common Rat and Its Parasites"; Frank, Henry S., "The Le Chatelier-Braun Principle. I. A Thermodynamic Proof"; Wu Ma Na, "The Solubility of Sodium Chloride in Saturated Solutions of Sodium Chlorate"; Fenzel, G., "Problems of Reforestation in Kwangtung with Respect to the Climate."

L. O. Howard

U. S. Dept. of Agriculture,
Washington, D. C.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFICATION OF KROGH'S DIFFERENTIAL MANOMETER

In 1929 Meyerhof and Schmitt[1] published an account of an investigation conducted by them on the respiratory quotients of nerves at rest and in activity, in the course of which they described a manometric method of determining in one operation the consumption of oxygen and the output of carbon dioxide. A solution of barium hydroxide and one of citric acid were kept separately in receptacles in the lower part of a bulb designed on the principle of one contructed by Warburg,[2] who used it for a different purpose. These investigators used three types of the bulb, differing in minor details. Carbon dioxide was absorbed by the barium hydroxide, and the consumption of oxygen was determined. Then the carbon dioxide was liberated by the addition of the citric acid to the barium carbonate formed. This procedure furnishes a convenient, rapid method for estimating the respiratory quotient.

The writer has found that this method can be used with a Krogh manometer,[3] after that instrument has been slightly modified by indenting the bottom of each of its bulbs to form two separate depressions for the reception of about one cc of solution in each. Bulbs of this type can be made by any glass blower. The partition between the two depressions should be made entirely across the bottom, and reach upward to about the center, of the bulb, as shown in Fig. 1.

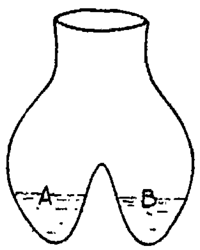


Fig. 1

Into A, Fig. 1, about 0.4 cc of a 5 per cent. solution of barium hydroxide is accurately measured, and into B the same quantity of a 15 per cent. solution of citric acid; in this bulb, let us suppose, is suspended the insect or other object under investigation. Into the compensating bulb, of the same construction, are measured the same quantities of these solutions, not for any chemical reaction, but to equalize the available air spaces in the two branches of the manometer. While the two solutions in the insect-containing bulb remain separate the barium hydroxide there absorbs the carbon dioxide given off by the insect, thus changing the position of the liquid, at first in equilibrium, in the two legs of the manometer. Suitable readings (on the attached scale) for the positions of the liquid, together with the known constants of the instrument, afford data for computing the oxygen consumption.

After these readings have been made the manometer is carefully raised from the water-bath in which, for suitable and uniform temperature, the bulbs have been immersed, and the two solutions in the insect-containing bulb are quickly mixed by gentle agitation until the mixture becomes clear, the stopcock remaining closed. The bulbs are then replaced in the water-bath. By very careful manipulation the mixing of the two solutions may be accomplished without removing the bulbs from the water bath, but apparently this precaution is of no advantage. The citric acid liberates the carbon dioxide from the barium carbonate formed during the insect's consumption of oxygen, thus producing a movement, in the opposite direction, of the manometer fluid, which immediately reaches a constant level. Readings are then made for the new position of the manometer fluid, after which all needed data are

[1] O. Meyerhof, and F. O. Schmitt. "Über den respiratorischen Quotienten des Nerven bei Ruhe und Tätigkeit," *Biochem. Ztschr*, 208: 445–455. 1929.

[2] O. Warburg. "Methode zur Bestimmung von Kupfer und Eisen und über den Kupfergehalt des Blutserums," *Biochem. Ztschr*, 187: 255–271. 1927.

[3] A. Krogh. "Ein Mikrorespirationsapparat und einige damit ausgeführte Versuche über die Temperatur-Stoffwechselkurve von Insektenpuppen," *Biochem. Ztschr*, 62: 266–279. 1914.

available for computing the carbon dioxide evolved. Corrections for volume should be made on account of the changes in the bulbs; otherwise the calculations are exactly similar to those for the method hitherto used with the Krogh manometer.

DAVID E. FINK

BUREAU OF ENTOMOLOGY

THE PHYLLOTAX—A PRACTICAL APPARATUS FOR DEMONSTRATING DIVERGENCE

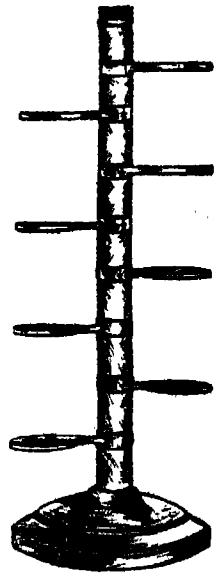
TEACHERS of botany have often found it difficult, if not impossible, to obtain adequate plant specimens for the purpose of properly illustrating their lectures on divergence. Even when such plant specimens are available, the fact remains that quite a number may be required to illustrate the main types of divergence.

I devised a few years ago an apparatus which, I think, will prove of some use. It consists of a metal stem along which are placed, at regular intervals, a number of leaves, each one being attached to a ring revolving about this stem, in order to give any desired divergence. If the divergence $\frac{1}{2}$ is wanted, two leaves should be met at regular intervals before the observer returns over the starting-point. Let us take a less simple case, for example the divergence $\frac{2}{5}$, which requires two complete revolutions around the stem before a leaf is found above the starting-point: there should then be five leaves, each forming with the next an angle of 144°.

All divergences have a value ranging from $\frac{1}{5}$ to $\frac{1}{2}$. The most common ranges are from $\frac{1}{3}$ to $\frac{2}{5}$, and are known as the "normal series." In illustrating divergence, it is of course more suitable to use the simplest cases, *i.e.*, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, and $\frac{2}{5}$. Such divergence as $\frac{4}{7}$ or $\frac{3}{8}$ can not be illustrated in a lecture. It might be convenient to indicate on the apparatus Fibonacci's angle: 137° 30′ 28″. This angle is the limit towards which the different values of the normal series converge, but it should never be considered as a type of divergence in itself.

DESCRIPTION OF THE APPARATUS

A metallic stem is vertically fixed on a stand. On the stem are placed, as stated before, equidistant revolving rings, each bearing a leaf. Every one of the rings has inscribed on it the fractions denoting divergence. It will be easily understood that the relative position of the fractions differs from one ring to the other. One would naturally expect to find these fractions on the fixed axis of the stem, *i.e.*, between the rings; setting every leaf to a predetermined fraction would give the divergence wanted. But this process has its drawbacks since, for instance, to get the divergence needed, we have to revolve the whole apparatus to find the figures. On the other hand, if the fractions are on the revolving rings and the stopping points for each leaf along the same vertical of the fixed axis of the apparatus, the observer will have only to face the stopping points and to move each leaf until the fractions for a given divergence are all set on the said stopping line.



HOW THE FRACTIONS ARE PLACED ON THE DIFFERENT REVOLVING RINGS

The first ring, whether at the top or at the bottom, will always remain in the same position for all demonstrations of divergence. On this first ring, it is not the leaf that is brought to the stopping mark, but a chosen point which is found on the ring 45° from the leaf. This prevents any fraction from occurring on the succeeding rings at the point of attachment of the leaves. Otherwise rather broad rings would be required for easy reading of fractions on account of the leaf at that point. The positions of all fractions on the other rings depend on the position of the mark on the first ring. The fraction $\frac{1}{2}$ on the second ring will be found 180° away from the mark of the first leaf, *i.e.*, 225° from the point of attachment. The fraction $\frac{1}{3}$ on this same ring will be 120° apart, instead of 180°, *i.e.*, 165° from the leaf. On the third ring the fraction $\frac{1}{2}$ will be 180° away from its position on the second ring and this will bring the third leaf to the original position of the first one. On this third ring the fraction $\frac{1}{3}$ will be 120° away from its position on the second ring, *i.e.*, 285° from the leaf. And so on.

JACQUES ROUSSEAU

UNIVERSITÉ DE MONTRÉAL, CANADA

SPECIAL ARTICLES

ONCHOCERCIASIS IN GUATEMALA

THE Harvard Expedition for the investigation of onchocerciasis in Guatemala has been working in that country since January 27. The disease in Guatemala is characterized by the formation of nodular tumors situated on or in the region of the head. The fibromatous tumors are of parasitic origin, and the adult male and female *Onchocerca coecutiens* are situated

in the central portion of the tumor. We have been able to demonstrate that three species of *Eusimulium* flies are concerned in the transmission of the disease. For the present and until careful comparison has been made with published descriptions and museum specimens these species have been designated as follows: Species A (probably *Eusimulium avidum,* Hoffmann), a small black fly some 2 mm in length; species B (probably *Eusimulium ochraceum,* Walker) about the same size or a little smaller with yellow thorax, the abdomen half yellow and half black and the legs mostly black; and species C (probably *Eusimulium mooseri,* Dampff), slightly larger than the others, with the thorax and most of the abdomen yellow and the legs very extensively yellow. All stages of development of *Onchocerca coecutiens* have been repeatedly observed in these flies, and the development has been traced from the time the fly just bites the infected individual and thus ingests the microfilariae from his skin, on through their passage and development in the thoracic muscles, head and proboscis. We have been fortunate in securing permanent specimens of the infective filarial form passing through and emerging from the labium of the proboscis. In this study, 4,572 flies have been dissected and examined microscopically. Other insects and particularly culicine mosquitoes are not concerned with the transmission of the disease.

The mosquito has a considerably longer proboscis than the *Eusimulium* fly and evidently inserts the proboscis deeply in sucking blood. The microfilariae of *Onchocerca,* which are not encountered naturally in the blood, but are found in the lymphatics of the skin, are not even ingested by the mosquito when it is fed on infected individuals. Possibly also the saliva of the mosquito repels the microfilariae of *Onchocerca coecutiens.*

In some of the cases in which the tumors have existed for long periods of time, disturbances of the eyes and loss of vision occur. We have been able to demonstrate microfilariae in such cases in sections of the peri-corneal conjunctiva, cornea and iris removed at operations or at autopsy. The continued presence and passage of the microfilariae through the lymphatics of the eye for long periods of time apparently give rise to an inflammatory condition and to a perivascular infiltration, in perhaps somewhat the same manner as occurs from the action of the trypanosome in the tissues of the central nervous system in sleeping sickness. In the course of time, peri-corneal, conjunctivitis, keratitis and iritis may result in such cases.

We have also investigated the blood and serum in the disease. Eosinophilia is present, and counts of eosinophiles of from 25 to 50 per cent. are usual. The serum of some of the cases of long standing gives a precipitin reaction with an aqueous or alcoholic extract of the tumors employed as antigen. However, a rabbit serum prepared by repeated intravenous inoculation of the animal with an extract of the tumors gave no such reaction.

In the clinical studies 1,383 individuals have been examined and the tumors removed in 261 cases. Some of the tumors have been hardened in Zenker's solution for histological study, while others have been used for the preparation of antigen and still others have been digested and dissected to obtain entire for study the adult male and female parasites.

The tumors (and the adult parasites within them) can be easily removed by operation under a local anesthetic, but in some cases the microfilariae continue to circulate in the body and are demonstrable in the skin and in some cases in the eye for at least several years. In order to rid the patient of the microfilariae which persist after removal of the tumors, experiments have been performed to discover a satisfactory filaricidal substance. Using a technique which gives a suspension in normal saline solution of an enormous number of motile microfilariae, it has been found that *in vitro* plasmoquinin in dilutions up to 1 to 10,000 effectively destroys the microfilaria. The motility of almost every parasite in the microscopical field ceases and they become apparently lifeless within thirty seconds; the several in the microscopical field which are not immediately killed no longer exhibit any lively movement (but may continue to bend more or less for 10 to 15 minutes) and are dead within about 20 minutes. Quinine in a solution of 1 to 5,000 produces somewhat similar results, but its lethal action is somewhat less marked while antimony compounds, neosalvarsan and mercurochrome are relatively ineffective. A serum prepared by repeatedly inoculating a rabbit with extracts of the adult filariae and embryos and with the tumors themselves has shown no filaricidal properties.

The members of the expedition, besides myself, are Dr. J. Bequaert, entomologist of the department of tropical medicine at Harvard University, Dr. M. Ochoa, parasitologist of the Board of Health of Guatemala, and Mr. B. Bennett, technician of the department of tropical medicine.

RICHARD P. STRONG

MOCÁ, MAY, 1931

INTRANUCLEAR INCLUSIONS IN LARYNGOTRACHEITIS OF CHICKENS

BEACH[1] has reported from this department the filtrability of the virus of laryngotracheitis in chickens. We wish in this place to record briefly the results of a histological study of spontaneous and

[1] J. R. Beach, SCIENCE, 72: 633, 1930.

experimentally produced cases and the finding in both of intranuclear inclusions.

The lesions are restricted to the respiratory tract and occur first and are most pronounced in the larynx and trachea. At the outset the surface epithelial cells show various forms of cellular degeneration, but inflammatory processes of various degrees in the submucosa and other parts of the mucous membrane soon follow. The destructive process in later stages is due to the combined effect of the virus and mechanical factors produced by edema, cellular infiltration, hemorrhages, and in a few instances secondarily invading bacteria. A small number of animals show bronchitis and peribronchitis, pneumonic areas, and hemorrhages in the lungs, while involvement of the nasal passages, communicating sinuses and eyes seems to be dependent upon the point of entrance of the virus.

Certain intranuclear inclusions can be demonstrated in the epithelial cells lining the mucous membrane as well as in those of the mucous glands of the larynx and trachea in many cases. These inclusions consist of round, oval or irregularly shaped, sharply outlined, homogeneous, acidophilic masses. Usually a single inclusion occurs in a nucleus. The size may be small, but it is often so large as to occupy most of the central portion of the nucleus, which then may be considerably enlarged. The nucleoli of the affected cells are commonly attached to the nuclear membrane, and the space between the inclusion and the nuclear membrane remains entirely unstained. The inclusions resist the solvent action of acetic acid, alcohol and chloroform; they do not contain fat or iron, but give the Feulgen reaction for thymonucleic acid slightly. Silver impregnation shows small argentophilic granules inside the inclusions. The inclusions described as well as other changes in the nuclei bear a close resemblance to similar structures found in such virus diseases as herpes, varicella, virus III of rabbits and submaxillary gland disease of guinea pigs.

OSKAR SEIFRIED

DEPARTMENT OF ANIMAL PATHOLOGY,
THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
PRINCETON, NEW JERSEY

IONIC EQUILIBRIA IN THE SERUM IN RELATION TO THE CRITICAL TEMPERATURE

IN our systematic researches on the critical temperature of blood serum (around 56° C.) we have so far purposely neglected the part played by the salts and we have been able to account for the observed phenomena by means of simple hypotheses which explained the facts satisfactorily without necessitating any assumption concerning ionic phenomena. However, we did not overlook this factor, neither did we underestimate its importance. We were only compelled to leave it aside in order to simplify arbitrarily a problem already so complex. We have now attempted to study this side of the question, and the purpose of this paper is to report a few preliminary results.

As it was necessary to respect as much as possible the integrity of the protein molecules, we only used distilled water as a means of disturbing the normal salt equilibrium of the serum. The first step was to study quantitatively the equilibrium: albumin-globulin, when progressive amounts of pure water were added to normal serum. The method used consisted in measuring the amount of light scattered at right angles of the incident light (more accurately, the value of $\log\frac{I_0}{I}$) as a function of the dilution. As the addition of water brings forth a precipitation of the globulins, the light scattered by the solution increases. It is known that the amount of light scattered is proportional to the number of particles (Lord Rayleigh), provided the latter are small with respect to the wave length of the light used and nearly spherical in shape. It was found that the addition of 1, and even 2 cc of water to 1 cc of serum did not determine much cloudiness, while if 3 cc were added the increase in the scattered light was very important. In other words, there is, in general, a sharp break in the curve around the point corresponding to a concentration of salts equal to 33 per cent. of the normal. If we assume that the value of the ratio $\frac{I_0}{I}$ is equal to 1 for pure serum, an addition of 200 per cent. of water will bring it to

TABLE I

LIGHT SCATTERED BY NORMAL HORSE SERUM, AFTER ADDITION OF DISTILLED WATER

Cc of water added to 1 cc of serum	Relat. concent. of salts, per cent.	Readings $= \log\frac{I}{I_0}$ After 1 hour	After 4 hours
Ser. undiluted	1	2.18	2.23
+ 1 cc water	0.50	2.12	2.14
2	0.33	2.06	2.08
3	0.25	1.54	1.50
4	0.20	1.30	1.30
5	0.168	1.17	1.21
6	0.143	1.15	1.16
7	0.125	1.12	1.14
8	0.115	1.12	1.14
9	0.100	1.13	1.15
10	0.091	1.15	1.17
11	0.083	1.17	1.19

about 1, 3, while an addition of 300 per cent. raises it to nearly 4. Between the concentration 0.33 and 0.25 per cent. of salts we observe therefore a particular instability of the serum, and the instability was maximum, in our experiments (normal horse serum, collected without especial precautions), immediately around 0.33 per cent. Table I gives the results of one experiment.

aspect was decidedly different in the cases of unheated serum, and of serum heated above 58°. In order to obtain figures proportional to the rate of sedimentation, it was only necessary to observe the scattered light at regular intervals of time, and to take the readings. This was very easily done in the instrument previously described.[1]

Fig. 1 expresses the results of one set of experiments, made with serum diluted with 5 times its volume of distilled water.

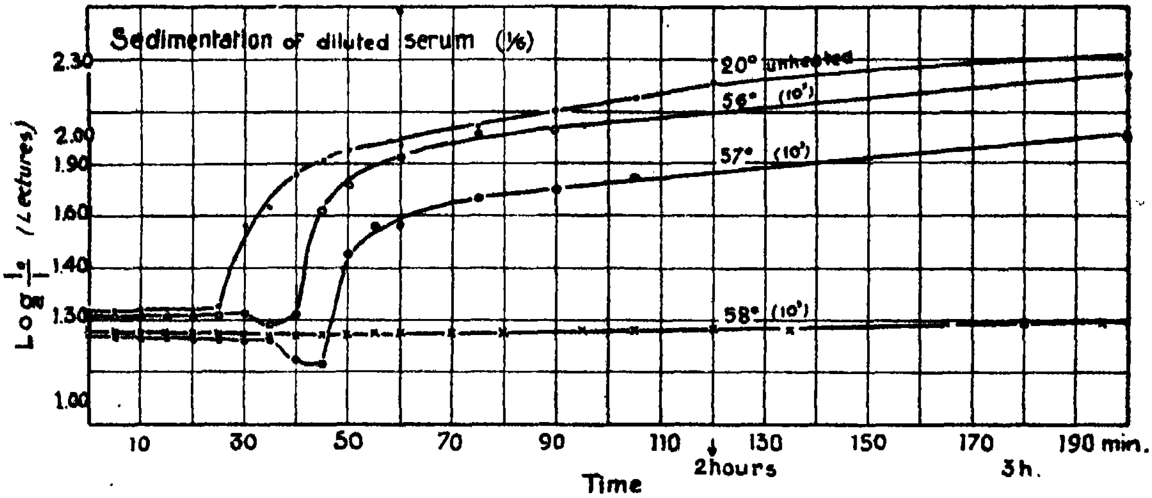


FIG. 1

When the serum is heated for 10 minutes previous to the addition of water, the fragility of the system albumin-globulin is increased, as shown by Table II. The increase in the amount of scattered light (expressed in the table by *decreasing* figures) begins sooner, in a more abrupt fashion, but only when the serum is heated above 55° C. When heated to 60° (always for ten minutes) the curves are totally different in shape.

TABLE II

LIGHT SCATTERED BY NORMAL HORSE SERUM UNHEATED AND HEATED PREVIOUS TO ADDITION OF DISTILLED WATER

Cc of water added to 1 cc of serum	Unheated	Heated at 56°	Readings = $\log \frac{I}{I_0}$	
			Heated at 60°	Heated at 64°
0	1.98	1.96	1.72	1.19
0.5	1.98	1.96	1.62	1.09
1	1.99	1.92	1.59	1.05
1.5	1.98	1.84	1.54	1.00
2	1.95	1.68	1.53	1.03
3	1.63	1.56	1.39	1.05
4	1.33	1.47	1.32	1.04
5	1.25	1.40	1.31	1.07

It was then attempted to determine the rate of sedimentation of the precipitated globulins, as their

It will be seen that the sera heated for ten minutes at 56° and 57° (in sealed tubes, of course) show a slight decrease in the value of $\log \frac{I_0}{I}$ (which correspond to a momentary *increase* in the amount of scattered light) after 35 minutes in the first case, and 40 minutes in the second case. Unheated serum shows a sudden and important *decrease* in the amount of scattered light, after 25 minutes, while the same decrease is observed after 40 minutes in the serum heated at 56° and after 45 minutes in the serum heated at 57°. The curves are practically parallel. This decrease is obviously due to the decrease in the number of scattering particles due to settling, and is a function of their number. The settling of the globulins can then be followed quantitatively. But a very important phenomenon was observed when the serum was heated for 10 minutes up to 58°, namely, the fact that *there was no decrease at all in the scattered light, no settling.* Fig. 1 shows indeed that the figures expressing $\log \frac{I_0}{I}$ are practically constant for two hours, and that even 18 hours later the change is much less marked than that which occurs in the serum kept at 57°. When the serum was heated at 60° no change whatever was observed in 22 hours.

[1] P. L. du Noüy, *Ann*, Inst. Pasteur, 45: 251, 1930.

The globulins do not settle, and remain in suspension for many days. The pH of the solution plays an important part in the phenomenon; but this side of the question will be taken up in another paper. Suffice it to say at present that the solution must be slightly acid in order to observe an immediate difference in the rate of sedimentation. With less acidity, the phenomenon is only postponed.

In the serum unheated, or heated below 57°, the phenomenon of sedimentation starts very abruptly, and is very rapid at first, as in a given volume the number of scattering particles is more than halved in 5 minutes. However, as Rayleigh's formula only holds for particles which are small with respect to the wave-length of light, and as we have at present no information concerning their size, we can not as yet interpret the figures satisfactorily.

Nevertheless, a new phenomenon can be added to the four which, as we have already shown, characterize the critical temperature of serum, namely, viscosity, rotatory power, scattered light, depolarization factor. But this last one brings forth something more, as it applies to the behavior of the globulins alone, when the total serum was heated at or above 58°. Without drawing any hasty conclusions, one can not help wondering if the destruction of the complement might not be connected primarily with the globulin fraction of the serum.

P. LECOMTE DU NOÜY

DEPARTMENT OF BIOPHYSICS,
INSTITUT PASTEUR, PARIS

THE POSSIBLE RÔLE OF MICRO-ORGANISMS IN THE PRECIPITATION OF CALCIUM CARBONATE IN TROPICAL SEAS[1]

FOLLOWING the same procedure carried out in the investigation of marine "calcium bacteria" by Drew, Kellermann and Smith, Lipman and others, extensive personal observations were made in the region of Andros Island, while the experimental studies were carried out in the laboratories of soil microbiology at the New Jersey Agricultural Experiment Station, at New Brunswick, New Jersey. Only a brief summary of these experiments may be presented here. The results so far obtained make it appear that the question concerning the rôle of micro-organisms in the formation of sediments in the ocean, especially their activity in the precipitation of calcium carbonate, may be reopened again.

In the course of a trip of three weeks' duration during the months of March and April, 1930, to the Great Bahama Banks, to Andros Island and to a smaller island off the west coast of Andros, or Williams Island, various samples of mud were collected with special instruments, at several carefully selected locations and from different depths, in order to carry out the investigations in the laboratory named above; likewise direct microscopic observations of the microflora of the material collected were made immediately, soon after the samples were taken.

At the laboratory in New Brunswick, experiments were begun first by counting the numbers of microorganisms in the mud, since to date there is no sufficiently definite information dealing with the number or with the quantitative distribution of organisms which might possibly take a direct or indirect part in the process of calcium carbonate precipitation. These experiments led to the discovery of certain interesting and characteristic differences in the different regions of the ocean.

In agreement with the observations of the earlier investigators, it was discovered—if we disregard the water of the high seas with its well-known low bacterial population—that relatively few bacteria occur in the white calcium carbonate mud of the Bahama Banks and off the west coast of Andros; the numbers of bacteria in the different layers of this mud, as determined by the plate method, vary from a few cells to 5,000, 10,000 and 100,000 cells per gram of moist mud. At other locations, however, as on the coast of Williams Island, and especially in the mangrove swamps situated farther inland, the number of bacteria increase considerably. The surface layers of the mangrove swamp of Williams Island, for example, contain over sixteen million bacteria per gram and, even at a depth of four feet, over two million bacteria could be found in one gram of material.

Among the organisms which have been isolated by special culture methods from the samples, there were many forms which have been for the first time found to exist on the coast of this interesting island. The existence of a typical microbial population was found both by direct examination and by laboratory studies.

Of this population, sulphur bacteria, Oscillatoria, certain diatoms and Protozoa play the chief part. It was possible to identify several colorless and red colored Thiobacteria and it was further possible to

[1] This is one of a number of papers resulting from The International Expedition to the Bahamas in 1930. The object of the expedition was to collect all possible data concerning the relation of the stability of the Bahama "Block" to the origin, migration and alteration of the sediments which mantle its surface. A further paper "On the Decomposition of Agar-agar by an Aerobic Bacterium," by Dr. Selman A. Waksman and Dr. Bavendamm, is being published. Dr. Bavendamm was appointed to the staff of the expedition by the Deutsche Forschungsgemeinschaft. All the bacteriological work was done with the advice and under the direction of Dr. Waksman at the New Jersey Agricultural Experiment Station.—Richard M. Field.

assign a new position to the rare *Beggiatoa mirabilis* of the Bahama Islands.

It is astonishing that such conspicuous forms, such as the sulphur bacteria, have never been mentioned before. It is equally surprising that the numerous anerobic bacteria found in the mud have been similarly disregarded.

As to the organisms which may be responsible for the precipitation of calcium carbonate, the following observations may be reported here:

Apart from the kinds which Drew and others have termed erroneously "calcium bacteria," going so far as to attach special names to them, there were found in many places numerous urea bacteria which to this day have escaped observation. These bacteria, like the denitrifying forms observed by Drew and other scientists, are able to precipitate calcium carbonate under certain conditions. Also the strictly anerobic sulphate reducing bacteria, which seem important in the process of calcium carbonate precipitation, were found to exist everywhere.

The presence of very active cellulose and hemicellulose destroying bacteria attracted special attention. These organisms were subjected to a closer investigation. Some of the bacteria are noted for their ability to dissolve agar-agar made from brown and red algae; these bacteria occurred in such vast quantities that they are believed to be responsible not only for the decomposition of the abundant organic matter in the mangrove swamps, but together with other bacteria they might be indirectly partly responsible in the precipitation of $CaCO_3$.

The author does not agree with Lipman's ideas (1929), whose conclusions on this subject have been based on experiments which were not sufficiently convincing; rather he is of the opinion that in reference to the vast calcium carbonate sediments in the tropical sea of to-day and of former geological periods we have to deal not with strictly chemical-physical, but primarily with microbiological processes. These results were obtained not only from the inspection of crude and pure cultures of the various organisms in the laboratory, but also from personal observation of the conditions *in situ*, as considered from the botanical-bacteriological-hydrobiological view-point; finally, from simple conclusions resulting from a study of bacteriological, botanical, geological, chemical, physical and oceanographic literature.

The author believes that the bacteriological process of calcium carbonate precipitation may be confined to certain locations. The shallow and richly manured mangrove swamps in particular may assist one in reaching this conclusion, for they represent an ideal habitat of bacteriological life, and it is here that we find especially pronounced bacterial activities.

The assumption that mangrove swamps or similar places represent the natural locations for the microbiological calcium carbonate precipitation is strongly supported by the observations of the geologists participating in the expedition. It is their opinion that we were possibly dealing with fresh or brackish water sedimentations. This view is in no way opposed to the results of the microbiological investigations, since we know that many of the bacteria mentioned may adjust themselves easily to a varying concentration of salt in the water, also that for similar processes related conditions have been found to exist.

The chemical-physical factors of this important geological process should of course not be disregarded. However, their importance may be no more than secondary and may serve to explain why such large quantities of calcium carbonate have not been precipitated at other places on the earth which possess virtually the same microflora and the same external features as the tropical sea.

We are dealing here with a complicated but not inexplicable collaboration of various factors which serve to make the problem of calcium carbonate deposits intelligible. How the different processes are probably related to each other and how the necessary investigations in the future must be carried out is to be discussed later in a detailed publication in German, probably to appear in the *Internationale Revue für die gesamte Hydrobiologie und Hydrographie.*

WERNER BAVENDAMM

TECHNISCHE HOCHSCHULE,
DRESDEN

BOOKS RECEIVED

BURT, CHARLES E. *A Study of the Teiid Lizards of the Genus Cnemidophorus with Special Reference to Their Phylogenetic Relationships.* Pp. viii + 286. 38 figures. U. S. National Museum, Smithsonian Institution. \$0.80.

COULTER, JOHN M., CHARLES R. BARNES and HENRY C. COWLES. *Textbook of Botany.* Volume II. Physiology. Revised and enlarged. Pp. viii + 307. American Book Company.

GLAISTER, JOHN. *A Study of Hairs and Wools Belonging to the Mammalian Group of Animals, Including a Special Study of Human Hair, Considered from the Medico-Legal Aspect.* Pp. 187. 145 plates. Misr Press, Cairo, Egypt.

GREGORY, JOSHUA C. *A Short History of Atomism.* Pp. 258. Macmillan. \$3.50.

LINDWORSKY, JOHANNES. *Experimental Psychology.* Translated from the German by Harry R. DeSilva. Pp. xix + 406. Macmillan. \$3.75.

MEISTER, MORRIS. *Heat and Health.* Pp. xviii + 237. 165 illustrations. Scribner's. \$1.08.

RUSSELL, G. OSCAR. *Speech and Voice; with X-rays of English, French, German, Italian, Spanish, Soprano, Tenor and Baritone Subjects.* Pp. xvii + 250. 217 figures. Macmillan. \$4.00.

WETMORE, ALEXANDER and BRADSHAW H. SWALES. *The Birds of Haiti and the Dominican Republic.* Pp. iv + 483. 26 plates. U. S. National Museum, Smithsonian Institution. \$1.00.

SCIENCE

VOL. 73 — FRIDAY, JUNE 5, 1931 — No. 1901

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

DR. KARL LANDSTEINER

NOBEL PRIZE LAUREATE IN MEDICINE, 1930[1]

By Professor STANHOPE BAYNE-JONES

THE UNIVERSITY OF ROCHESTER

IT would be fitting to dedicate a meeting of the American Association of Immunologists to the celebration of the award of an honorable international prize to a great immunologist. It is especially appropriate for us to dedicate this meeting to the celebration of the award of the Nobel Prize in Medicine for 1930 to one of our former presidents—Dr. Karl Landsteiner. The association takes this first opportunity it has had, since he gained that well-deserved recognition of his accomplishments, to give him from this group what he has received from his individual friends—admiration for his scientific achievement, confidence in the power of his methods of research to solve many of the problems of specificity, gratitude for the useful facts which his discoveries have placed in our hands, and an expression of affectionate personal esteem.

Dr. Landsteiner has done his work in several cities which could take pride in his achievements. A glance at his *curriculum vitae* and the list of more than 200 of his publications will show why this is so. It will be seen that no claim can equal that of Vienna, his birthplace and the place where all his fundamental work was begun and much of it completed. But for many years he has been at work at the Rockefeller Institute in New York, and the contributions from his laboratory there have formed a most significant part of the immunological literature of this country.

[1] Presidential address delivered at the annual meeting of the American Association of Immunologists, April 1, 1931, at Cleveland, Ohio. From the Department of Bacteriology, School of Medicine and Dentistry, University of Rochester, Rochester, New York.

He was born in Vienna, Austria, on June 14, 1868. He is the son of Leopold Landsteiner, doctor of laws, and his wife Fanny, née Hess. He followed the medical course at the University of Vienna, receiving the degree of doctor of medicine in 1891. Of great importance for his future work was the chemical training he received in the laboratories of Hantzsch in Zurich, Emil Fischer in Würzburg and E. Bamberger in Munich. In 1896 he became assistant under Dr. Max von Gruber in the Institute of Hygiene at the University of Vienna. From 1898 to 1908 he was an assistant under Professor A. Weichselbaum at the Pathological Institute of the University of Vienna. From 1909 to 1919 he was pathologist to the Wilhelminspital in Vienna. After the disruption caused by the war, he went to Holland, where he was pathologist at the R. K. Ziekenhuis, at the Hague, from 1919 to 1922. In 1922 he came to the Rockefeller Institute for Medical Research in New York and has been a member of the institute since that time.

During the thirty-six years since Landsteiner's first paper on cholic acid, his contributions have expressed the numerous interests of an original and versatile mind. They form a vast accumulation of facts discovered by an industrious and extraordinarily skilful investigator. It is undoubtedly true also, as Zinsser has said, "that the amount of work that he has inspired probably far exceeds in number of titles the communications which stand in his name." With a violation of chronological sequences, Landsteiner's contributions to knowledge can be grouped into reports of his investigations in chemistry, in pathological anatomy, in experimental infectious diseases, and in serology and immunology. It would be instructive to review them all. But time and this occasion require passing over with only a brief mention many papers which remain sources of fundamental information in their field.

Of these the chief are the records of studies of two infectious diseases—syphilis and poliomyelitis. In 1906, in collaboration with Finger, Landsteiner succeeded in transmitting syphilis to apes, repeating and extending the earlier work of Metchnikoff and Roux. During the investigation important observations were made upon immunity in syphilis, and at this time Landsteiner had much to do with the perfection of methods for the recognition of *Treponema pallidum*, particularly in the recommendation of the use of the *dark field microscope*. Three years later, in 1909, he succeeded with Popper in producing poliomyelitis experimentally in monkeys. This was the first time this mysterious disease had been reproduced experimentally. In the first observations and the studies continued during 1910 and 1911 with Levaditi and others, Landsteiner worked out the filterable nature of the virus, its localization in tonsils and other organs and disclosed many facts about the disease.

These studies, however, seem to have been interludes in the pursuit of the major quest of his life—the investigation of processes of immunity and of mechanisms of serological reactions and above all the problem of the specificity of antigens. His method of attack was derived from his thorough training in the fundamental science, especially chemistry. In the days of the beginning of his investigations, it seems to have been as clear to Landsteiner as it is to us today that the secrets of serology will be unlocked by the biochemist. He had the chemical faith of Ehrlich, and, if I may make a comparison which Landsteiner's modesty never would permit, he had a surer footing than Ehrlich in chemical rationalization. With fidelity to ascertain chemical facts, he has never wandered into the mysticism of some of Ehrlich's receptor-visualizations.

Among the first of Landsteiner's immunological studies were those which led to his discovery of human isoagglutinins and the blood groups of man. Before 1900 he was investigating the agglutinating and lytic actions of various sera to test whether individuals like species were serologically recognizable. In a foot-note to a paper on this subject, published February 10, 1900, he stated that the sera of some normal men agglutinated the red corpuscles of other men. The results of more numerous observations soon allowed Landsteiner to state explicitly that isoagglutination was a normal occurrence after the mixing of certain bloods, and by 1901 he had enough data to substantiate a biological conception of individual differences in blood. In that year he published an account of three blood groups and correctly recognized the existence of the two major agglutinogens in the corpuscles and the two agglutinins in sera which constitute the basis of this type of serological differentiation of individuals. At the same time he pointed out the significance of isoagglutination for transfusion. The next year, 1902, his associate, Sturli, in cooperation with Decastello, continuing the work, described the fourth blood group. In 1902–1903, Landsteiner suggested the use of blood group determination for the identification of individual human blood for medico-legal purposes. It is to be regretted that Landsteiner, in agreement with the findings of Ehrlich and Morgenroth and Todd in animal blood, did not seem to think it necessary to summarize this knowledge in an orderly four-group classification in some paper in 1902 or 1903—or at least long before his first four-group classification in the manuscript which he sent to the publisher on August 11, 1908, for printing in the 1909 edition of Oppenheimer's "Handbuch der Biochemie." Such a

publication would have kept the literary atmosphere clear of the swarm of papers on questions of priority and nomenclature which have vexed this subject. But it seems now entirely plain to me that with the exception of the later discoveries of von Dungern and the Hirschfelds on the mode of inheritance of the factors determining the blood groups and the racial distributions of these groups, these original observations and deductions of Landsteiner and his associates contain all the fundamental discoveries and suggested applications of blood-grouping reactions. An immense benefit to humanity, coupled with an advancement of science, has flowed from these discoveries. The Nobel Prize in medicine for 1930 was awarded to Landsteiner in recognition of the importance of his investigations in isohemagglutination. It is one token of a just reward.

To continue the review of Landsteiner's studies in isoagglutination requires another rupture of chronological sequences, because his experimental investigations of agglutinable substances in the corpuscles have been episodes in his main theme—the search for cell-antigens conditioning individual specificity and finally the specificity of antigens.

A brilliant series of experiments in collaboration with Donath, published in 1904, clearly elucidated the nature of paroxysmal hemoglobinuria through the demonstration of an autolytic antibody which combined at low temperature with the antigen in the corpuscles of the same individual. This was the discovery of a type of cold-lysin and cold-agglutinin which has assumed importance in later studies beyond its interesting connection with paroxysmal hemoglobinuria.

A distinct renewal of Landsteiner's investigations of agglutinable substances in red corpuscles occurred after his arrival in this country in 1922. Since then, in collaboration with van der Scheer, Levine and others he has published numerous papers on work centering around the principles of species specificity, the chemical nature of cell antigens, and the blood groups of man and other animals. Analyses of the bloods of species hybrids, especially the mule, have demonstrated the transmission of parental agglutinable factors, and analyses of the bloods of the higher primates have exhibited their relationship to man, and also significant differences from man. By the use of human sera, animal sera, and especially by the use of absorbed sera of rabbits immunized by injections of human blood, Landsteiner has shown that there are enough differences between cells to justify the surmise "that almost every blood has peculiar serological features." He has coordinated this astonishing individual specificity with the known results of transplantation experiments, in which grafts as a rule succeed only with tissue from the same individual. Several of the newly discovered agglutinogens, notably those designated M and N, are inheritable in accordance with Mendelian laws. As a consequence of the additional agglutinogens discovered by Landsteiner the number of recognizable blood groups has been greatly increased. But Landsteiner has pointed out at the same time that while this result has a bearing upon the general problem of biochemical individuality, it has minor practical consequences, "since the main application of blood grouping, namely for transfusion, has, broadly speaking, reached a satisfactory stage." Fortunately for the increase of knowledge, Landsteiner seems to have an abiding interest in the phases of minor practical consequence!

It will be recalled that in 1906 and 1907 Landsteiner was interested in experimental syphilis, immunity in syphilis and the demonstration of spirochetes. It is natural that he, as a serologist, should have been interested also in the Wassermann reaction, which at that time was beginning its oracular progress. It is natural also that, as a scientific serologist, Landsteiner should have submitted this reaction to a searching analysis with a skilful technique in broadly conceived experiments. The results of these experiments laid the foundation of all modern sero-diagnosis of syphilis, since they introduced the use of a lipoidal antigen. Landsteiner, with his associates Müller and Pötzl, found that extracts of normal organs would fix complement in the presence of syphilitic serum, and finally that the alcoholic extract of normal heart muscle was a more effective antigen than any of the saline extracts of either normal or syphilitic organs. These studies were not the result of a sudden diversion of Landsteiner's attention to a new field of clinical serology. They were a rational consequence of previous investigations of the ability of colloids, and especially lipoids, to absorb complement. In a paper in 1921, Landsteiner comments also on the possible relationship of these alcoholic extracts of heart muscle to the lipoidal-like body described by Bang and Forssman—the so-called heterogenetic antigen—and expresses the opinion that the Wassermann "antigen" is a hapten. Thus the investigation which led to the introduction of an alcoholic solution of lipoidal substances as an antigen for the very practical procedure of the Wassermann reaction is seen to be in line with his fundamental theme of the chemical nature of antigens. It brings Landsteiner a step further in his researches on the complex-antigens and the fruitful study of the substances he has called "haptens."

The great work of Landsteiner's life has been his experimental investigation of the specificity of anti-

gens. These studies have had such brilliant results in his own hands and have been the basis of such remarkable discoveries by others that most immunologists regard them as even more worthy of the Nobel Prize than his discoveries of the blood groups.

Landsteiner has for a long time recognized that of the two kinds of substances set in the inner mysteries of immunology and serology—the antibodies and the antigens—the latter are more susceptible than the former to chemical attack. Antigens, available in bulk and in relative purity, can be manipulated chemically. Antibodies, on the other hand, present in much smaller amounts in almost indissoluble mixtures, are surrounded with difficulties as impenetrable as those which until recently have impeded the approach to enzymes. At one time, Landsteiner studied models of antigen-antibody reactions with inorganic colloids. The great value of this investigation was to convince him that while colloidal phenomena conditioned the course and part of the mechanism of these reactions, they could not account for their specificity. As the problem of specificity has engaged his thought and effort for many years, he wisely decided to apply his chemical knowledge and philosophy through his original methods to the investigation of antigens in an attempt to find the correlation between serological specificity and chemical constitution. With the enthusiasm of an investigator who has a vision of one of the secrets of natural phenomena, Landsteiner has said that "the knowledge of specific chemical differentiation of animal and bacterial organisms is one of the most beautiful fields of theoretical serology." This knowledge also has become of the greatest practical importance.

The nature of the immunizing mechanism, which remains unexplained, seems to require that the start in these investigations be made with the highly complicated soluble proteins. Landsteiner himself, and others, have attempted repeatedly to cause the production of antibodies in animals by the injections of lipoids, polysaccharides, cleavage products of proteins and synthetic peptides. In some of his experiments with lecithin, with the specific fraction of the Forssman heterogenetic antigen, and with azoalbumoses, Landsteiner has obtained some evidence that antibodies may be formed when these substances are injected into an animal. In general, however, for the present, the results of the work of Wells, Osborne and many others may be summarized in a sort of negative law—stating that no substance other than a complete protein has been conclusively shown to be a functional antigen, capable of inciting the formation of antibodies. It seems, however, that this question is not absolutely settled.

The proteins with which Landsteiner has dealt have been the so-called simple proteins, like those of the blood serum, and the complex proteins extractable from the cells of animals and bacteria. It is generally accepted that the simple proteins are large aggregations of amino acids. The complex proteins are more or less firm combinations of proteins with lipoids or proteins with polysaccharides. Species specificity has been shown to reside chiefly in the simple proteins, from the precipitin reactions of which the zoological tree can be roughly constructed. Individual specificity of cells, on the other hand, is most closely bound up with the characteristics of the complex proteins. Reactions with these substances disclose the presence of similar antigens in totally unrelated species. The basis of the specificity of the natural simple soluble proteins remains undisclosed, although the work of Wells, Osborne and many others has pointed out differences in proteins which might account for their different serological reactions. Landsteiner's work, as will be shown, has provided many facts which might be used by analogy to account for the specific behavior of unaltered simple proteins. But the proof has not been brought as in his experiments with chemically altered and complex proteins. He has expressed the opinion that the method of partial synthesis of antigens which he has used can not be substituted for the chemical study of natural antigens and that it is still impossible to say whether small parts of the antigenic molecule are sufficient to determine specificity in the natural antigens. "It is possible that in natural antigens several complicated factors may be involved."

The material of most of Landsteiner's creative investigations has been two sorts of complex antigens: (1) Artificially altered proteins conjugated with non-antigenic substances of slight or great complexity, and (2) the naturally occurring complex proteins, compounds of protein and lipoid or protein and carbohydrate. In all the cases studied, the protein part of the compound has been the functional antigen. The attached compound has conferred specificity upon the complex. These attached substances, while unable to stimulate the production of antibodies, were found to have the remarkable capacity to enter into specific union with the antibodies elicited by the injection of the complex. To these non-antigenic but specifically acting substances, Landsteiner has given the name haptens. His investigations of altered and complex proteins and the reactions of haptens have greatly advanced the knowledge of many fundamental phenomena of immunology and serology.

The pioneer experiments in this field were made in 1906 by Obermayer and Pick, who found that the specificity for species was altered or lost when proteins were iodized, nitrated or diazotized. They assumed that the substitution of hydrogen atoms in the benzene ring of the aromatic amino acids in the

protein by I, NO_2 and N=N brought about these changes. Subsequently Landsteiner and his associates, especially Wormall, have shown that the serological properties of the antigens prepared by Obermayer and Pick are not simply dependent upon the nature of the substitutes. In addition, later experiments with the Forssman antigens, the haptens of pneumococci and with simple compounds have shown beyond doubt that the groupings necessary for specificity may be entirely devoid of aromatic radicals. In the reactions employed by Landsteiner a common feature has been the production of alterations in the salt-forming groups of the protein molecule. Furthermore, the experiments of Obermayer and Pick gave no basis for expecting the precise results of the specific inhibition reactions and other serological phenomena produced by the isolated simple compounds and haptens. While the investigation of Obermayer and Pick must be honored as a pathfinding research, with heuristic influence, it is necessary to make this clear distinction between the altered protein antigens studied by them and the synthetic antigens prepared in an original manner by Landsteiner.

About ten years after the work of Obermayer and Pick, the further step was taken by Landsteiner when he prepared complex antigens whose specific groups were composed of substances of known chemical composition coupled in a definite manner to otherwise relatively unaltered proteins. The chief chemical processes used by Landsteiner in the preparation of these compounds have been the formation of acyl complexes by treatment of proteins with acid anhydrides and acid chlorides and the production of a great variety of diazo-compounds by the application of Pauli's reaction. In this way, Landsteiner opened up the field of investigation of the relationship between chemical constitution and serological specificity. Out of a long catalogue of synthesized antigens and their reactions only a few can be chosen to illustrate some of the general principles of specificity which Landsteiner has established.

One of the first principles established by Landsteiner is that the specificity of the artificial complex antigen depends largely on the attached substance. The species specific character of the protein fraction is not always entirely annihilated, since strongest reactions are obtained with homologous antigen-antibody mixtures, even when the isolated native protein gives no reaction with the antibody to the complex antigen. The experiments showed further that the ability of these antigens to react with antibodies is not conditioned by a specific chemical group, such as the aromatic portion of the protein molecule, but is a general property of the attached chemical group. The acid groups have the greatest influence upon the "electivity" of the reactions. In fact, the important action of acid groups upon specificity suggests that the part of the protein bearing free carboxyl groups may have a special significance for the specificity of proteins. Immune sera against these compounds act strictly specifically or show group reactions. The immune sera for the azoproteins prepared with para-aminophenylarsinic acid are good examples of sera which react in different degrees with a series of antigens containing the arsinic acid radical. More strictly specific reactions were obtained with compounds containing diazotized para-aminobenzoic acid, exhibiting the overwhelming effect of acid radicals upon specificity.

Another general principle established by Landsteiner from the results of these experiments is that the spatial configuration of the specific group in the antigen molecule plays a most important rôle. This effect was noted in studies of antigens composed of protein coupled with d- and l-phenyl-p-aminobenzoyl-acetic acid, and was established beyond question by Landsteiner's more recent experiments with dextro, levo and meso tartaric acid-protein compounds. It was easy to differentiate by precipitin reactions between the d- and l-tartaric acid antigens in dilutions of 1:100 and upward. From the results of these experiments published in 1928, Landsteiner postulated that since steric isomers, differing only in the relative positions of H and COOH groups around an asymmetric carbon atom, are acted upon selectively by immune sera, stereo-isomerims may be expected to play a significant part in the serological specificity of carbohydrates such as those discovered in bacterial antigens. This prediction has been substantiated in the results of the protein-glucose and protein-galactose compounds successfully synthesized by Avery and Goebel and by their brilliant studies of the synthetic pneumococcus antigens.

A remarkable discovery of far-reaching analytical significance made in the course of these experiments was the capacity of the simple substances in their natural state, un-diazotized and unattached to protein, to give reactions with the antibodies formed to the complex protein. These reactions have been of two sorts, positive phenomena of the anaphylactic type in sensitized animals, and specific inhibition phenomena in animals and in the test-tube mixtures of antibody and the particular non-antigenic substance. Undoubtedly these reactions, which can be classed in the special group of hapten reactions, have great significance in connection with idiosyncrasies and many of the phenomena of hypersensitivity. It seems also that they may assist in bringing order into the observations of anomalous serological reactions which have been thought by some to differ quantitatively from results expected from some of Ehrlich's assump-

tions. In the final estimation they are apt to prove of greatest value in the determination of the specifically active groups in natural as well as artificially altered proteins. Striking examples of this are specific inhibitive reactions of optical isomers and the discovery of Wormall, who applied this analytical method to halogenated proteins, that the active group in iodized protein is apparently 3:5 diiodotyrosin.

Landsteiner's investigations of the natural complex antigens have proceeded *pari passu* with the researches on the artificially prepared protein-chemical compounds. One phase of the work has been advanced by discoveries in the other phase in such a way that a separation of the two is somewhat forced. Landsteiner has studied chiefly the Forssman heterogenetic antigen, but has also investigated the complex antigens of bacteria, similar to those discovered by Avery and Dochez and Zinsser and Parker. It seems established from these researches that the individually specific and heterogenetic antigens of animal cells are chiefly compounds of protein and lipoid-like substances, while the specific cellular antigens of bacteria are proteins conjugated with polysaccharides. In both cases, the protein serves the function of immunizing, eliciting the formation of antibodies, while the lipoidal or carbohydrate fraction, the hapten, incapable of giving rise to antibodies, reacts in a number of ways with these antibodies in the test-tube and in the animal body. Aside from this important bearing upon specificity, these lipoidal and carbohydrate haptens have been shown to have important anaphylactic effects in actively and passively sensitized animals, effects which may explain the origin of shock following the systemic introduction of protein split products and decomposition products of various organisms. Their effects suggest numerous new investigations of phenomena of hypersensitivity. In addition, these haptens in themselves are substances of considerable biochemical interest. In attempts to determine the nature of the lipoidal fraction of the Forssman antigen, Landsteiner and Levene have discovered hitherto unknown lipoids, which yield on hydrolysis a reducing sugar and components of lipoids. From such experiments by Landsteiner it is inevitable that chemistry will be enriched by new compounds and that serology and immunology will advance both as a science and as a practically serviceable field of knowledge for man and animals.

In order to give the researches of Landsteiner upon the specificity of antigens their proper setting it would be necessary to review the many biological processes in which specificity is the inner mechanism, to recapitulate at least the evidences for a conception of the evolution of proteins correspondent with the evolution of species. Even without a detailed review of these subjects, it is obvious that his work may have a bearing upon such diverse processes as specific ferment action, resistance to infection, systematic zoological and botanical classifications, and the serology of heredity. Landsteiner, fully aware of the manifold implications of his discoveries, has pursued a course of rational experimentation, describing many facts, expressing generalizations when fully justified, and occasionally suggesting an hypothesis. He is entirely worthy of the name experimenter in the sense in which Claude Bernard used it when he said, "To be worthy of the name, an experimenter must be at once a theorist and practitioner. While he must be completely master of the art of establishing experimental facts, which are the materials of science, he must also clearly understand the scientific principles which guide his reasoning through the varied experimental study of natural phenomena."

Those who have known Dr. Landsteiner best have expressed their high appreciation of his rare personal characteristics of simplicity, sincerity, gentleness and charm. The writer of this review, who has had less opportunity than they to know him, can nevertheless join cordially in the universal expressions of admiration of his accomplishments and in the regard and veneration felt for him by his friends all over the world. This review itself is clearly an inadequate summary of his work. It is presented in the spirit in which Dr. James addressed his Medicinal Dictionary in 1743 to the great Dr. Meade, "Sir: ——— you are to consider this address, if it be agreeable to you, as one of the rewards of merit; and if otherwise, as one of the inconveniences of eminence."[2]

OBITUARY

LOUIS HERMANN PAMMEL

THE death of Dr. Louis Hermann Pammel marks the passing of a pioneer in the field of botany in the upper Mississippi Valley. Dr. Pammel served as the head of the department of botany at Iowa State College for forty years. He died on March 23, en route to Ames from California, where he and Mrs. Pammel spent the winter.

[2] In the collection of material for this review of Dr. Landsteiner's work I have been greatly aided by Dr. Peter K. Olitsky. I acknowledge with sincere thanks his constant willingness to assist me generously and am obliged to him for many helpful suggestions.

Dr. Pammel was born at La Crosse, Wisconsin, in 1862 and graduated from the University of Wisconsin in 1885. The year following was spent in the laboratory of Dr. W. G. Farlow at Harvard University. The years of 1887, 1888 and 1889 were spent at the Shaw School of Botany, Washington University, where he received the degree of Ph.D. under the direction of Dr. William Trelease.

The staff of the botany department at the time he began his work here in 1889 consisted of one member, himself. The present staff of thirteen specialists, offering sixty-six courses, attests to the growth of the department under his leadership. Many of the workers in this field in the state colleges and the U. S. Department of Agriculture received their training and inspiration for botany from this teacher.

The field of taxonomy was Dr. Pammel's specialty, and he made a number of intensive studies of the flora found in the plains region and in the Rocky Mountains. The major portion of the herbarium of this institution, comprising 180,000 sheets, was collected by him.

Dr. Pammel's earlier activities were in the field of plant pathology. In the early 80's he made a study of the cotton root rot. His contribution on Ozonium root rot of cotton led the way in the then unexplored field of soil plant pathogens. His studies of black rot of cabbage established the fact that it was a bacterial vascular parasite, a contribution to a virgin field.

He was the author of numerous bulletins and two books, "Weeds of the Farm and Garden" and "Poisonous Plants." A third volume, "Honey Plants of Iowa," in collaboration with Miss C. M. King, was in preparation at the time of his death.

Dr. Pammel's last major activity, and the one by which he was best known to the public, was in the field of conservation. He wrote the Iowa conservation bill and served as the first chairman of the Iowa Conservation Board. During his régime thirty-six state parks were acquired, and the lakes of the state were placed under the control of the Conservation Board, making a total area of 10,000 acres dedicated to state park purposes. Pammel Park, named in his honor, was dedicated the past summer.

He was an active member and a past officer in numerous scientific and honorary societies.

Dr. Pammel is survived by a widow and six children.

A. T. Erwin

Iowa State College

MEMORIALS

A memorial tree, a Norway spruce, has been planted near the path to Eaton Library on the Tufts College campus in commemoration of the late Dr. Fred D. Lambert, of the department of biology. A rough boulder bearing a suitably inscribed bronze plate will be placed at the foot of the tree with appropriate ceremony.

A mountain peak with an altitude of 13,601 feet, on the boundary between Inyo and Fresno counties, California, has been officially named in memory of the late Professor Alfred Prater, of the department of mathematics at the University of California at Los Angeles. Prater Peak was discovered and charted by Professor Prater and Mrs. Prater during a trip in the summer of 1928, shortly before his death.

Mr. C. C. Paterson, president of the British Institution of Electrical Engineers, on June 5, in the Sunderland Central Library, Museum and Art Gallery, unveiled a plaque to the memory of Sir Joseph Wilson Swan, inventor of the first practical incandescent electric lamp and a pioneer in the science of photography. The plaque was presented to Sunderland, Swan's birthplace, by the institution. The institution and a number of citizens of Sunderland have formed a committee with the object of founding Swan memorial scholarships in electrical science. An appeal has been made for a sum not less than £5,000. Over £2,500 has already been received.

A remembrance stone built into the new Battersea Power Station, London, was unveiled on April 23 to commemorate the centenary of the discovery by Michael Faraday in which lay the origin of the dynamo and starting point of the utilization of electric power. The Governor-General of Canada, Lord Bessborough, formerly director of the London Power Company, called for the unveiling of the stone in a speech telephoned from Ottawa, which was transmitted to a large company by amplifiers.

RECENT DEATHS

Dr. Karl Joseph Belar, research associate in biology at the California Institute of Technology, who was thirty-six years of age, was killed on May 25 in an automobile accident.

Mr. Emil Torday, known for his work on the anthropology of Africa, died on May 9, aged fifty-six years.

Nature reports the death of Professor J. E. Edwards, principal and professor of mathematics and physics at Queen's College, London, author of well-known text-books on the calculus, on May 16, aged seventy-seven years, and of Professor T. R. Glynn, emeritus professor of medicine in the University of Liverpool, on May 12, aged ninety years.

SCIENTIFIC EVENTS

GIFT FROM MR. HARKNESS OF AN EYE INSTITUTE TO THE PRESBYTERIAN HOSPITAL AT THE COLUMBIA MEDICAL CENTER

Mr. Edward S. Harkness has given an Eye Institute to the Presbyterian Hospital of the Medical Center of Columbia University.

The institute will be under the direction of Dr. John M. Wheeler, professor of opththalmology at the College of Physicians and Surgeons and head of the ophthalmological service at the Presbyterian Hospital. In an account given out by Dean Sage, of the hospital, it is stated that the new building will be twelve stories in height, and will be the first unit in the group of projected specialty hospitals which are to surround the great central garden court lying to the south of the main buildings of the Medical Center. It will provide facilities not only for treatment and hospital care of all classes of eye patients, but also for the teaching of medical students and the training of nurses in this special field, and for routine study and advanced scientific research in all matters relating to this branch of medicine and surgery.

The building will cover an area of 167 by 97 feet. It will be U-shaped in plan with two ward wings extending to the south and forming an entrance court 90 feet wide by 57 feet deep. There will be 114 patients' beds, allotted as follows: Men's wards, 30; women's wards, 18; children's wards, 11; semi-private rooms, 13; private rooms, 12. Residential accommodations will be provided for professional, administrative and nursing staffs to the number of fifty.

The main entrance is in the south court facing 165th Street opening into a spacious waiting hall. The medical reception, examination and emergency treatment rooms adjoin this hall on its easterly side. The administrative offices are on the westerly side and extend through to the private patients' hall, which is entered from Fort Washington Avenue. Private practice offices for staff physicians surround the private patients' hall.

The second floor contains the residential quarters for the staffs and the private offices of the director of the institute. Above this are the ward floors, and the floors devoted to semi-private and private patients' rooms. Provision has been made for beds at all rates, from free ward beds to the most costly private suites.

The operating rooms will be upon the highest main floor and will be surrounded by the usual accessory rooms for operating service. Grouped with the operating rooms in the upper stories will be a large lecture hall, teaching and experimental laboratories, and the departmental library.

Full use will be made of the roofs for open air and sun treatment, relaxation and rest. The central portion of the building, rising above and giving access to the roofs, contains lounge and sun rooms and recreational facilities.

The building of the eye institute has been carefully planned throughout to embody the best and most effective arrangement and equipment in this branch of medicine. In appearance it follows in general the architecture of its predecessors in the Medical Center. Its practical plan was said to be reflected in a simple exterior treatment, which is frankly modern but in full accord with established principles of design. The material is brick with some sandstone trim, all similar in color to the original group. By reason of its location upon a lower site and its modest proportions it has been given a pronounced horizontal treatment in contrast to the adjacent buildings.

THE SIXTEENTH INTERNATIONAL GEOLOGICAL CONGRESS

The Committee on Organization of the Sixteenth International Geological Congress has voted to postpone the meeting of the congress for a year, to the latter part of June, 1933. It was felt that the generally adverse economic conditions throughout the world made this postponement desirable.

The following topics for discussion have been tentatively adopted:

Measurement of geologic time by any method.
Batholiths and related intrusives.
Zonal relations of metalliferous deposits.
Major division of the Paleozoic system.
Geomorphogenic processes in arid regions and their resulting forms and products.
Fossil man and contemporary faunas.
Orogenesis.

The routes of the excursions have been selected and work is well advanced on the preparation of the guide books. A series of excursions before the congress of from 5 to 12 days in length will cover the eastern and central states. These will as far as possible be arranged to appeal to specialists in various branches of geology. There will also be a number of short excursions in the vicinity of New York. During the sessions of the congress, which will last about a week, several short trips will be made to points of interest in the vicinity of Washington. The excursions after the congress will include two in the north-central states—one for glaciologists in Illinois, Iowa and Wisconsin and the other for mining geologists in the

Lake Superior iron and copper districts, each of about ten days' duration—and two transcontinental trips, each of about thirty-five days.

A circular is now being prepared giving more detailed information. This will be sent to all those who received the first circular and to others interested who request it from the Secretary, Sixteenth International Geological Congress, U. S. Geological Survey, Washington, D. C.

THE AMERICAN SCHOOL OF PREHISTORIC RESEARCH

THE American School of Prehistoric Research, of which Dr. George Grant MacCurdy, of Yale University, is director, has been carrying on excavations in Palestine for three seasons jointly with the British School of Archaeology at Jerusalem. At present (May, 1931) they are digging in caves near Athlit, at the foot of Mount Carmel, with very gratifying results.

The sites include Mugharet-el-Wad, Mugharet-es-Schrool, Mugharet-et-Tabon and Mugharet-el-Kebara. The last is at Zickron Yacob and is proving to be exceptionally rich. It was opened this season, so that its complete sequence of cultures has not yet been uncovered. In the deposits containing a culture known as Mesolithic—older than the Neolithic and younger than the Paleolithic they have already found a mass burial of eight or ten interments. These duplicate in many respects the one found at Mugharet-el-Wad last season. Near the skeletons was a cache of 150 bone beads. Mesolithic microliths are very abundant. Objects of bone are also abundant and well preserved. Many harpoons have also been found.

The prize specimen is a complete haft in bone of a knife or sickle twelve inches in length. The animal represented in the round and terminating the handle is probably a goat. The longitudinal groove for insetting the microliths is too narrow for any but very small ones. The decorated portion of a similar haft in bone was found at Mugharet-el-Wad two years ago.

Most important of all is the skull of a Neandertal child found embedded in breccia of a Mousterian deposit. The find was made by Mr. Theodore D. McCown, representing the American School. This is the third skull of a Neandertal child discovered to date: the first by Henri Martin at La Quina (Charente) during the war; the second by Miss Dorothy Garrod in the rock shelter of Devil's Tower at Gibraltar in 1926. Miss Garrod is in charge of the joint excavations near Athlit. Mr. McCown is a graduate of the University of California and was with Dr. MacCurdy in Europe last summer as a student of the American School of Prehistoric Research.

SUMMER MEETING AND TOUR OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE American Phytopathological Society will hold its third annual summer tour and conference from July 28 to 31, under the immediate direction of Drs. H. W. Anderson, Leslie Pierce, M. W. Gardner and C. T. Gregory.

Assembling on July 28 at Cairo, Illinois, the party will move early on the twenty-ninth along U. S. Route No. 1, visiting the Ozark fruit and vegetable districts where the control of plant diseases will be noted, as well as the nut industry of the region. Original chestnut varieties, the Latham red raspberry in a southern habitat, and the peach harvest will be among the interesting features of the first day's trip, ending at Carbondale, Illinois.

From Carbondale, the party on the second day will proceed to Vincennes, Indiana. *En route,* the famous Johnson County fruit region, the new wilt-resistant water-melon varieties developed by the Iowa Agricultural Experiment Station, and the old Rappite settlement of New Harmony will be visited.

The third and last day will be spent in and around Vincennes, where the federal government's experimental control of the oriental fruit moth and bacterial spot of peaches will be the center of attraction.

Among the special features of interest to scientists, aside from the regular diseases of the region, will be the unusual effects of the extremely low temperatures of the winter of 1929–1930 and those attributable to the 1930 drought.

Besides periodic discussions and conferences on the various exhibitions seen by the travelers, specialists on the soils, entomology and horticulture of the visited region, associated with the Illinois and Indiana Agricultural Experiment Stations, will accompany the party to explain those phases of the work more strictly allied to their respective fields.

For those not driving cars will be furnished. Dr. H. W. Anderson, of the Illinois Agricultural Experiment Station, Urbana, should be addressed for further particulars and arrangements.

IN HONOR OF PROFESSOR R. W. WOOD

As has been stated in SCIENCE the honorary doctorate of philosophy has been conferred by the University of Berlin on Professor R. W. Wood, chairman of the department of physics of the Johns Hopkins University. The diploma was presented to Professor Wood at the German Embassy in Washington, with addresses by the German ambassador and Professor Henning, of the Reichsanstalt for Physics and Technology. Professor Henning said:

Owing to a fortunate circumstance I have been assigned by the Faculty of Philosophy of Friedrich Wil-

helm University in Berlin to hand you, Professor Wood, the diploma of doctor of philosophy *honoris causa.* I am very happy indeed that through the kindness of Ambassador von Prittwitz I am enabled to execute my mission thus solemnly on German territory, and I should therefore at the same time like to thank the ambassador on behalf of Berlin University.

The designation of doctor *honoris causa* is the highest distinction a German university can confer. I may add that the University of Berlin rarely confers this honor and that it is only made possible with the consent of all members of the faculty.

In conferring this diploma upon you, Professor Wood, the Berlin physicists desire to do homage to you. As a master of experimental science you have opened up new roads for science, undeterred by theoretical speculation, and through your investigations concerning the optical nature of matter, especially of gases and vapors, you have made important disclosures concerning the structure of molecules and atoms.

However, the diploma is not only intended to express our admiration for the fundamental researches you have made; it is also a token of thanks for the many inspirations you have given German physicists in their work. In this connection I should like to mention only such men as Franck, Pohl and Pringsheim, who are all closely allied with the Berlin Physical Institute. Moreover, you are also not unknown to other German physicists. Several of your numerous publications have appeared in German reviews and we have several times had the pleasure of seeing you in Berlin. We are proud to know that three and a half decades ago you received part of your scientific training in Berlin. What you had learned of German science you repaid later with high interest after having returned to America.

The doctor's diploma, which in the first place represents a personal honor, is also a greeting from Berlin University to the celebrated Johns Hopkins University in Baltimore. I should be particularly happy if it might also be looked upon as a greeting from German natural scientists doing research work to their American colleagues. Exact research in natural science is a field of work which knows no political boundaries. Personal opinion on the historical development of the world around has no importance for it. I am convinced that this opinion is also fully shared in the United States. I have evidence of this daily in the fulfilment of my task here in Washington, which is devoted to the collaboration of the Bureau of Standards with the "Physikalisch Technischen Reichsanstalt." Physics is truly international. Mankind honors and admires the great man who has shown new ways towards the knowledge of nature regardless of what his nationality may be.

You, Professor Wood, have experienced this often, for many honors have been bestowed upon you abroad. Permit me to add one more doctor diploma to the many you already possess and to ask you to accept from Berlin University the title of Doctor of Philosophy.

Permit me also, in handing you the diploma, to read to you the letter which the dean of the faculty of philosophy addresses to you.

The letter of transmittal from Professor Jaeger, dean of the faculty of philosophy of the University of Berlin, reads:

Die Philosophische Fakultät der Friedrich Wilhelms-Universität zu Berlin hat Ihnen den Titel eines Doktors der Philosophie honoris causa verliehen. Es ist mir eine angenehme Pflicht, Ihnen dies mitzuteilen und das Diplom darüber zuzustellen.

Ihre ausgezeichnete Experimentierkunst, verbunden mit scharfem, unvoreingenommenen Beobachtungsblick hat Sie zu so vielen überraschenden, zum Teil ganz ungeahnten Entdeckungen in allen Zweigen der physikalischen Optik geführt, dass ich auf eine Aufzählung verzichten muss. Nur die grösste und schönste sei erwähnt, die Ihren Namen für alle Zeiten in die Annalen Ihrer Wissenschaft eingetragen hat: Die Auffindung der Resonanzstrahlung bei Gasen und Dämpfen aller Art. Keine Atomtheorie der Gengenwart und Zukunft kann an den Tatsachen vorübergehen, welche Sie als Erster an dieser Strahlung, beobachtet und beschrieben haben.

Mit besonderer Freude erinnert sich die Fakultät bei dieser Gelegenheit, dass Sie einen Teil Ihrer physikalischen Ausbildung an ihr erhalten haben, dass Sie auch später mehrmals auf kürzere Zeit in das physikalische Institut unserer Universität zurückgekehrt sind. Sie ist stolz auf die Erfolge ihres ehemaligen Schülers.

Indem ich Ihnen, sehr geehrter Herr Doktor, zu der verleihenen Würde, der höchsten, welche die Fakultät zu vergeben hat, auf das herzlichste gratuliere, bitte ich Sie, den Ausdruck meiner ausgezeichneten Hochschätzung entgege nehmen zu wollen.

SCIENTIFIC NOTES AND NEWS

CAPETOWN UNIVERSITY conferred the honorary degree of doctor of science on General Smuts on May 19 in recognition of his scientific achievements and with special reference to his election as president of the British Association.

THE Technical Institute at Zurich, on the occasion of its seventy-fifth anniversary, conferred an honorary doctorate on Professor Ludwig Prandtl, of the University of Göttingen.

OGLETHORPE UNIVERSITY, Atlanta, Georgia, has conferred the doctorate of laws on Dr. Harlow Shapley, director of the Harvard College Observatory.

DR. WILLIAM HENRY WELCH, of the Johns Hopkins University, received on May 20 at the University of Frankfurt the Harben Medal, the highest honor awarded by the British Institute of Public Health. The institute meets on the continent every other year and Frankfurt was chosen this year in honor of the

late Paul Ehrlich, the eminent bacteriologist. It was the first session in Germany in nineteen years.

DR. GOTTLIEB HABERLANDT, professor of botany in the University of Berlin, has been elected a foreign member of the Physiographical Society of Lund.

DR. HANS DRIESCH, professor of philosophy at Leipzig, has been elected an honorary member of the Philosophical Society at Budapest and of the Psychological Society of Buenos Aires.

SIR JAMES FRAZER, the British anthropologist, has been elected an honorary master of the Bench of the Middle Temple, London.

DR. BERNARD SACHS, of New York City, was elected president of the American Neurological Association at the recent meeting at the Boston Psychopathic Hospital. He succeeds Dr. James B. Ayer, of Boston.

DR. J. A. CHATARD has been elected the fifth president of Osler Historical Society at the Johns Hopkins University.

THE following officers were elected by the Philadelphia section of the American Society of Mechanical Engineers at its recent annual dinner: J. M. Barnes, *chairman;* E. P. Kiehl, *vice-chairman,* and George C. Crowfoot, *secretary and treasurer.*

LEIGH J. YOUNG, associate professor of silviculture at the University of Michigan, was elected on May 6 president of the Michigan Forestry Association.

SIR SIDNEY F. HARMER, treasurer of the Ray Society, London, has been elected president *ad interim* in succession to the late Professor W. C. M'Intosh.

Nature reports that the council of the Royal Society of Edinburgh has awarded the Makdougall-Brisbane Prize, for the period 1926–30, to Dr. Nellie B. Eales, department of zoology, University of Reading, for her papers "On the Anatomy of a Foetal African Elephant" published in the *Transactions* of the society. The Bruce-Preller Lecture, to be delivered on July 6 by Professor Horace Lamb, will be devoted to a commemoration of the centenary of the birth of James Clerk Maxwell. On June 15, Professor A. H. R. Buller, professor of botany in the University of Manitoba, will address the society on "Recent Advances in our Knowledge of the Higher Fungi."

AT a meeting of the Royal College of Physicians on May 14 the following appointments to lectureships were announced: Lumleian (1932), Dr. C. E. Lakin; Goulstonian (1932), Dr. L. J. Witts; FitzPatrick (1932), Dr. James S. Collier, and Croonian (1933), Dr. W. E. Dixon.

PROFESSOR G. H. F. NUTTALL, Quick professor of biology at the University of Cambridge, will retire in October after serving for twenty-five years. *Nature* reports that by the terms of Mr. Quick's will, the benefaction must always be used to promote "study and research in the sciences of vegetable and animal biology." Authority is given to the managers, however, to propose to the university changes in the particular field of biology with which the chair shall be associated. From 1906 until 1919 this field was defined as protozoology; in 1919 parasitology replaced protozoology. The managers now recommend to the university that the next tenure of the Quick professorship should be associated with the field of research which they define as the study of the "Biology of the Cell." If this recommendation is approved, they intend to offer the chair to Mr. D. Keilin, who has for some years been carrying on research work of this type in the Molteno Institute.

DR. R. L. KAHN, who was one of three scientific men in honor of whom resolutions were adopted by the Michigan Legislature, is referred to in a recent issue of SCIENCE as a member of the staff of the State Department of Health. Dr. Kahn resigned his position there three years ago and is now director of laboratories of the hospital of the University of Michigan and assistant professor of bacteriology.

DR. JOHN CHARLES BOILEAU GRANT, professor of anatomy at the University of Manitoba Faculty of Medicine, Winnipeg, since 1919, has been appointed to the chair of anatomy at the University of Toronto to succeed Professor J. Playfair McMurrich.

AT Harvard University, Dr. George Bernays Wislocki, associate professor of anatomy at the Johns Hopkins Medical School, has been appointed Parkman professor of anatomy. Dr. John Lewis Bremer, associate professor of histology, will become Hersey professor of anatomy, and Dr. Frederic Thomas Lewis, associate professor of embryology, will become James Stillman professor of comparative anatomy.

DR. LEONARD CARMICHAEL, professor of psychology in Brown University, has been appointed visiting professor of psychology in Clark University for the academic year 1931–32. Dr. Carmichael will give a graduate seminar in sensory psychology and will be a member of the general departmental seminar. Dr. Clarence Henry Graham has been appointed assistant professor of psychology in Clark University. He has been given a one-year's leave of absence at the beginning of his appointment in order that he may continue as National Research Council Fellow in the department of general physiology at the University of Pennsylvania.

DR. IRA VAUGHAN HISCOCK, associate professor of public health at Yale University, has been promoted to a professorship.

DR. S. M. TROXEL, of the Du Pont Rayon Company, has become a research associate at the U. S. Bureau of Standards.

MRS. FLORENCE W. NICHOLS, of Ames, Iowa, has been appointed editor of the Iowa Academy of Science to replace Dr. G. H. Coleman, of the University of Iowa, who has resigned.

THE Weston fellowship in electrochemistry for 1931–32 has been awarded to Mr. Marlin E. Fogle, M.S. in chemical engineering of the University of Iowa. He will carry out his research in electrochemistry at Columbia University under Professor C. G. Fink.

AT the University of California Dr. R. J. Trumpler, of the Lick Observatory, has been granted leave of absence for a year from July 1, for study in Europe. In the department of mathematics, Professor B. A. Bernstein has been granted leave from July to December to complete papers on the foundation of mathematics and a book on the algebra of logic. Dr. S. E. Flanders has been given an extension of leave until December 31 to continue his collecting of insect parasites in Australia and elsewhere. J. W. Gilmore, professor of agronomy, has leave from July to December to study fiber-bearing plants and soils in Mexico. In the department of anthropology, Professor A. L. Kroeber has been granted leave from January 1, 1932, to June 30, to accept a visiting professorship at Columbia University. Professor R. H. Lowie has been granted leave from July 1 to June 30, 1932, in order that he may serve as chairman of the division of anthropology and psychology of the National Research Council, and Professor M. Randall of the chemistry department has been given a sabbatical leave from July 1 to June 30, 1932, for study in Europe.

DR. W. A. NOYES, who is spending a year in Europe, attended the meetings of the Bunsen Society and the German Chemical Association in Vienna. He gave a paper before the Bunsen Society on "Die Elektronen Struktur des Stickdioxyd." On June 4 he lectured before the Heidelberg Chemical Society on "Oxydation und Reduktion als Elektronenvorgänge," and gave the same lecture in Karlsruhe on June 15. Dr. Noyes will represent the University of Illinois and the American Chemical Society at the Faraday Centenary in London on September 21.

AN illustrated lecture, based on his botanical trip through New Zealand, was delivered on May 20, by Dr. Charles J. Chamberlain, at the University of California in Los Angeles. Dr. Chamberlain is professor emeritus of the University of Chicago and lecturer in botany at the University of California at Los Angeles during 1931. The lecture was arranged by the Sigma Xi Club of the university.

DR. ARTHUR BEVAN, state geologist of Virginia, gave lectures on May 25 at Oberlin College on "The Geology and Mineral Resources of Virginia" and on "The Geologic History of the Appalachian Mountains in Virginia."

PROFESSOR ROSS AIKEN GORTNER, head of the division of biochemistry in the University of Minnesota, made the principal address at the Phi Kappa Phi Recognition Day Convocation at North Dakota Agricultural College on May 20. His subject was "Biochemistry and the World To-day." In the afternoon of the same day he addressed those faculty and student groups primarily interested in biological problems on the subject "Colloids and Water in Living Processes." In the evening he gave the annual Phi Kappa Phi lecture, speaking on the subject "Science and Civilization."

THE following message from President Hoover was read at the recent annual banquet of the chemical industries in New York: "The chemical industries are foremost among those which ally themselves continuously with workers in science, thereby quickly transforming discoveries of creative research into practical products for human use. To all industries founded upon research the nation and the world look for the advancement which scientific development makes possible for mankind. The comprehensive gathering on this occasion made up of chemists, engineers, industrialists and salesmen symbolizes the close bond so desirable in all industry. In your continued progress I wish you success."

THE annual meeting of the eastern section of the Seismological Society of America will meet on June 11 and 12 at the University of South Carolina. Professor G. D. Louderback is president.

THE Medical Research Club of the University of Illinois College of Medicine held its two hundredth meeting in the library of the research laboratory building on May 27. The following program was given: Greetings from President Chase; Greetings from the Graduate School, Dean A. H. Daniels; "The Origin and Aims of the Club," Dean D. J. Davis, first president of the club; "X-ray Diffraction of Studies of Natural Materials Including Human Tissues," Dr. George L. Clark, professor of chemistry, University of Illinois. The Research Club was founded soon after the University of Illinois had taken over the College of Physicians and Surgeons,

as the College of Medicine of the university. Since its formation a chapter of Sigma Xi, a Medical History Club and a Clinical Conference have been founded. Each organization holds bi-weekly meetings.

THE Southwestern Archeological Federation met on May 16, at San Diego, California, for its second meeting of the year. The San Diego Museum acted as host to the organization. Papers were presented by Charles Amsden, of Los Angeles; Odd S. Halseth, of Phoenix, Arizona, and Spencer L. Rogers, of San Diego. Membership of the society includes teachers, professional archeologists and laymen interested in the problems of early man in America.

THE Storrow Fellowships in geology and geography, given in memory of James J. Storrow, of Boston, by Mrs. Storrow, are again available. Information in regard to them can be obtained from Arthur Keith, chairman of the fellowship committee, division of geology and geography, National Research Council, Washington, D. C.

BEQUESTS in the will of William E. Harmon include the sum of $1,246,385 for the Harmon Foundation.

BY the will of the late Otto M. Eidlitz the Presbyterian Hospital at the Columbia University Medical Center will receive $229,576; the Roosevelt Hospital $153,056. Cornell University receives $25,000.

THE French Ministry of Education announces that Mr. William Nelson Cromwell, a lawyer of New York, has contributed $50,000 to provide each of ten investigators with about 100,000 francs to use for scientific research.

DURING the sixth annual Aircraft Engineering Research Conference on May 27, Dr. Joseph S. Ames, president of the Johns Hopkins University and chairman of the National Advisory Committee for Aeronautics, put in operation equipment for aeronautical research at Langley Field, Virginia. This consisted of a full-scale wind tunnel and a seaplane channel. The tunnel has an oval-shaped throat measuring 60 by 30 feet, permitting the testing of full-size airplanes in an air stream at velocities up to 115 miles an hour. The seaplane channel is 2,050 feet long, a narrow tube of concrete filled with water and covered with a sheet metal house to prevent sunlight and winds from affecting measurements on seaplane floats and flying boat hulls. It has what is said to be the smoothest riding trolley car in the world, a special device for towing floats and hulls which runs on wide rails constructed to be as smooth as the still water in the long basin.

Museum News reports that the Natural History Museum at San Diego, California, has selected the site for its new building, the plot of ground in Balboa Park formerly occupied by the Civic Auditorium, diagonally across the Prado from the present building. This plot has been officially allotted to the museum by the Park Board, along with enough room to the north or west to care for future growth. The building to be erected will include exhibition halls, research laboratories, children's museum, library, auditorium and other requirements for an up-to-date museum. Mr. W. Templeton Johnson has been retained as architect and is already at work on plans not only for immediate needs but for the ultimate development of the site. The cost of the plans has been defrayed by Miss Ellen B. Scripps.

THE Council of University College, Hull, has decided to put into operation a scheme of fishery research, which is to be organized by Professor A. C. Hardy, under the department of zoology and oceanography. The scheme provides for an investigation over a period of five years of the distribution of plankton in the North Sea. A new section will be added to the accommodation of the department and the scheme includes the appointment of three research biologists. The capital expenditure will be borne by the college, but the greater part of the maintenance charges will be met by a grant from the treasury, which has been made on the recommendation of the Development Commissioners. A grant towards the cost has also been made by the Fishmongers' Company.

THE Aeronautical Research Institute of Tokyo Imperial University was opened in the presence of the Emperor on May 11. The building, which cost £380,000, has 14 acres of floor space for departments engaged in the specialized study of aeronautical problems. It is equipped with air tunnels, one of which is over three yards in diameter, and can generate a wind of a velocity of 135 m.p.h. for testing, while another reproduces the low air pressures and temperatures of altitudes up to 6,000 feet.

THE area of the Pinnacles National Monument, California, recently was enlarged to include 1,926.35 acres of additional lands adjacent and continuous to its north, east and west boundaries. Proclamation effecting this enlargement was signed by President Hoover on April 13. The total area of the monument is now 4,906.61 acres. It is administered by the National Park Service of the Department of the Interior. The newly-added area was donated to the government by the County of San Benito, California, and is of value from an administrative standpoint and also scientifically and educationally. The principal natural exhibits of the monument, as the name implies, are a series of spirelike rock forms of volcanic origin which rise from 600 to 1,000 feet above the floors of its several canyons, forming a landmark

visible many miles in every direction. The formations are extraordinary in shape and beautiful in coloring. Unusual caves and subterranean passages add to the beauty of the Pinnacles National Monument. According to the custodian of the monument, W. I. Hawkins, the caves are of a type he has encountered nowhere else, and represent vividly the processes of world-building. In his opinion the massive grandeur of these caves is second only to the Carlsbad Caverns in the national park of that name. In addition to the area of almost 2,000 acres which the County of San Benito donated for the enlargement of the monument, condemnation proceedings are now under way for the purpose of acquiring a private holding of 160 acres which was embraced within the original monument boundaries.

Nature describes an exhibition of British glass and glassware held in the exhibition hall of Messrs. Selfridge and Company. The exhibition was organized by the Glass Manufacturers' Federation in order to indicate to the general public the variety and quality of the products of the glass industry. The exhibits included artistic glassware and fine crystal tableware; glass bottles and jars of various shapes and sizes; sheet-glass in different forms and plate-glass from ⅛-inch in thickness to 1½-inch; glass transparent to ultra-violet light, and glass which excludes about 80 per cent. of the heat rays. The varied range of exhibits of chemical, scientific, laboratory and medical glassware, and of fused silica glassware, gave evidence of the remarkable progress that has been made in these branches of the industry. The application of glass in the electrical industry was illustrated by wireless valve bulbs; electric lamp bulbs, which are produced by automatic machinery; a 10 kw. electric lamp, such as is used in lighthouses and in aerodrome pilot lights; photocells; and neon lights for decorative and publicity purposes. Two large blocks of fine optical glass were shown, and also a polished telescope disc of 24 inches diameter. Amongst the spectacle lenses exhibited were samples of specially computed cataract lenses of light weight and trifocal lenses made by fusing as many as six pieces of glass to form the complete lens. Spun glass, known as glass silk or glass wool, was shown in skeins and also woven into cloth and mats. This is now being largely manufactured and used for heat insulation purposes on boilers and steam-pipes. It is more efficient than many other substances used for this purpose, and, in the form of mattresses or strips, can be easily and quickly applied or removed.

DISCUSSION

IS AN INTERNATIONAL ZOOLOGICAL NOMENCLATURE PRACTICABLE?

THE article under this title by Dr. C. W. Stiles in SCIENCE for January 3 suggests that an affirmative answer to his question meets with grave difficulties (in which we shall all agree), and that those difficulties have been increased by events at the last International Congress of Zoologists, held in Padua, 1930. Is it not possible to take a more hopeful view of the situation?

When one looks back at the great divergences in principle and practice that obtained only 35 years ago, one must concede that the International Commission on Zoological Nomenclature has worked wonders, and no small part of its success has been due to the labors of Dr. Stiles himself as its secretary. That the ground thus gained is to be given up because of a temporary setback is hardly to be admitted. That, however, could scarcely fail to be the result if a local section of zoologists, especially so important a section as the zoologists of the United States, were to break away and adopt their own code. Their example might well be followed by other groups and the curse of Babel would redescend upon us.

As one who has been striving for many years to harmonize conflicting views, and to help on united action, I beg permission to make a few plain comments on the remarks of my friend and colleague, Dr. Stiles.

The source of the trouble was an interpretation of the phrase "Binary Nomenclature." What Dr. Stiles in his heart of hearts thinks this means I don't know; he has, I fancy, not always held the same view. As secretary to the commission, however, he has, ever since the phrase was interpreted by an opinion of the commission, very properly upheld that interpretation. Some of us, both within the commission and outside it, have always questioned the correctness, even the validity, of that opinion, and a movement to alter the opinion has been gathering force, with the result that at Padua there was in the section of nomenclature a large majority in favor of the change—a change, be it noted, not of the rules but of their interpretation. As I pointed out in the meeting, the adoption of this interpretation, while satisfying what I may call the intellectual conscience of the majority, need not cause the alteration of a single name.

Now I do not propose, any more than Dr. Stiles, to discuss this particular proposition. There are arguments on both sides. The real trouble is this. The resolution of the section upset an opinion of the commission; but the chairman of the section was bound to transmit the resolution to the general session of the congress. Here I entirely agree with Dr.

Stiles that the congress should have referred the question back to the commission, with or without a recommendation in its favor. To everybody's surprise, the president put the bare question and declined discussion. Naturally, in the circumstances, the motion was carried. Certainly this was a pure mischance. There was no deep-laid conspiracy to override the commission. Looking back after the event one sees that either the chairman of the commission or its secretary should at once have protested on a point of order. Unfortunately they, like the rest of us, were taken aback by the totally unexpected action of the president. But because of a frank difference of opinion on a relatively "trivial" question (I use Dr. Stiles' own epithet), and of an unpremeditated irregularity in parliamentary procedure, it is suggested that the bonds of union are *ipso facto* broken. Whatever our particular opinions, surely we must dismiss such an idea as out of the question.

What the best alternative may be, I am not sure. It is a pity that another resolution, rather suddenly sprung on the congress, prevents it from meeting again for five years. We can not wait so long. The question of procedure might well be laid before the permanent committee of the congress, which should be competent to smooth out the difficulty. If it is not competent no local group of zoologists can undertake the decision.

Such is the situation, and such is a possible way out. I have left on one side many subjects which Dr. Stiles brought into the discussion, because I do not wish to complicate a simple issue. There is only one on which I would beg leave to say a word. Rightly or wrongly, my friend Dr. Stiles speaks as though this were a dispute between Americans and Europeans. What he means by "Americans" I am not sure. "Europeans" also is a term occasionally construed in more than one sense. However that may be, there are zoologists in Asia, Africa and Australasia who may claim consideration. Then he seems to write as though all "Americans" held (or might be expected to hold) one view, and all "Europeans" another. So far as the latter are concerned that certainly is not the case. Dr. Stiles indeed admits a divergence of view in Berlin; there is no less difference of opinion in London. We have as much respect for law as the citizens of the United States, but we set science before nationality and allow the individual a right to his opinion. We wonder at, but have not yet learned to imitate, the well-drilled organization of American zoologists.

Perhaps the contrast between our views may be made clearer if I suggest that Dr. Stiles takes an "international congress" to mean a meeting of nations through their official representatives; I take it, so far as pure science is concerned, to mean a meeting of men and women from all parts of the world, irrespective of nationality and rising above it.

F. A. BATHER,
Member of The International Commission on Zoological Nomenclature
LONDON, ENGLAND

A CONFERENCE ON HEREDITY AS APPLIED TO MAN

DR. LYON'S[1] appeal for a conference on the subject of heredity as applied to man is a most timely one and should receive the most serious consideration. That such a conference has never been held may be ascribed chiefly to two causes. The first is that some biologists (there are of course many exceptions) have been rather unwilling to accept the pedigrees of human families, which for the most part do not extend over three generations, as adequate evidence of the inheritance of certain characters. They maintain that the matings were not controlled; the genetic constitution of the parents was unknown and the results can not be accepted. They have ignored the statistical side of the problem. Although statistics has its limitations in the solving of the problems of inheritance, it may be of advantage in some places. For example, in a family in which many members had died of cancer, Pearl found that the death-rate from this disease was twice that of the population at large from the same cause. This would suggest that cancer was inherited in this family, but the proof would not be unassailable. When, however, the death-rate from cancer was calculated for the corresponding age groups from the population in general that had been represented in this family, it was found that cancer was 196 times as prevalent in this family as in the general population. Such figures leave little room for argument.

Again, when a family is reported in which a disease has been present in four or five members through two or three generations, such evidence is not always accepted as proof of heredity. When, however, to such a statement is added the fact that this disease is one which many practitioners never encounter in a lifetime of practice due to its rarity, the significance of the high incidence in one family is multiplied many times.

The second cause for the lack of interest in the subject is the ignorance of the medical profession as a whole of the importance of heredity as an etiological factor in the production of disease. Their ignorance arises through the fact that as medical students the vast majority received little or no training in the field of genetics. That which they did get held little application, as far as they could see, to the art of healing. They obtained no instruction whatever in

[1] SCIENCE, 73: 421, 1931.

that most fascinating of studies, inheritance of disease in man. The results have been that our practitioners know little about inheritance of normal characters, and less about inheritance of disease. They have even been scornful of such an idea, so that one practitioner not so many years ago indignantly demanded to be shown "a club-footed ovum," when inheritance of this defect was being discussed. They know in a vague way that certain conditions "tend to run in families," but how they run or how to investigate the history of such a family so that the record will be of value is unknown to them. There are, of course, many exceptions to this statement, but in the main it is true. Hence a meeting of biologists, statisticians and medical men should prove enlightening and stimulating to all.

Naturally, the attitude of the public on matters relating to disease is apt to be determined by their medical advisers. With the medical profession apathetic concerning the great field of preventive medicine that lies here, it is not to be wondered at that the public has little information on the subject. The average practitioner is apt to feel that the matter is outside his sphere, that the diseases showing heredity are rare, and only encountered occasionally by the specialist. The number of cases showing heredity of disease in any doctor's practice is apt to be in direct proportion to his knowledge of and interest in the subject. To the ophthalmologist, the importance must be constantly evident, yet many of them know little of inheritance. Cataract, glaucoma, optic atrophy, myopia, etc., are inherited in a great many instances, and are by no means uncommon. The neurologist has difficulty in naming ten diseases which come under his specialty without mentioning several that are inherited. The family doctor who is not a specialist encounters many cases of diabetes, gastric ulcer, anemias, hemorrhagic diseases, cancer, many of which have a background of inheritance. The numerous reports which are published showing pedigrees of these diseases do not represent the extent to which they are inherited; they merely indicate the occasional doctor who is interested in heredity. When we have educated our profession concerning the important part which inheritance plays in the production of disease; when we incorporate into their medical course a period of study embracing the fundamentals of genetics as applied to disease in man, then we may expect a more interested attitude after graduation, and a keener comprehension of the responsibility that is theirs in educating the public.

Because the whole subject is so closely bound up in the minds of the public with what we are pleased to term the "inalienable rights of man," the very attempts to study the problem calmly and sanely are thwarted by the reactionaries who insist upon placing emotion before fact. The problem must be met, and the first step toward it is the accumulation and sorting of facts which are known. How they are to be dealt with presents still another question. Dr. Lyon notes the huge sums expended by philanthropists and social organizations on the improvement of the environment, and contrasts it with the neglect shown to the study of heredity. There was an old story that in an insane asylum the patient was occasionally tested as to his ability to return to society as a normal or near normal citizen. The test consisted in the emptying of a trough of water with a bucket; into one end of the trough was pouring a stream of water through an open tap. When the patient turned this off, he was adjudged sufficiently sane to be dismissed. The increasing expenditures for our public institutions that care for the derelicts of society are beginning to pinch. Many of these unfortunates will still be with us even after we have done our utmost from both the environmental and hereditary standpoints; but in the meantime how long will society continue to expend thousands upon improvement of the trough and upon larger and more efficient buckets? When will it become sane enough to turn off the tap?

MADGE THURLOW MACKLIN
MEDICAL SCHOOL,
UNIVERSITY OF WESTERN ONTARIO

THE CULTIVATION OF A NEMATODE PARASITE OF AN INSECT

THE nematode parasite of the Japanese beetle reported by Fox and the writer[1] has been found in a limited area in New Jersey during 1929, 1930 and 1931. It has not been found in a large number of grubs obtained from other parts of New Jersey and from Pennsylvania. In the locality referred to the mortality of the beetle grubs was high during the two previous years due to the activity of the nematode.

Steiner[2] studied the parasites taxonomically and found that they belonged to the family Oxyuridae and described the form as a new genus and species under the name of *Neoaplectana glaseri*.

The nemas are cultivated on standard meat infusion agar plates containing 1 per cent. dextrose, and having a reaction of pH 7.4. Gravid, ovoviviparous females from infected grubs are placed on the surface of the plates together with a water suspension of an actively growing yeast. After two days at room temperature the surface of the plates swarms with larval nematodes which soon mature. From four to five days are consumed in the development of each generation and transfers are usually made after the second generation.

[1] SCIENCE, 71: 16–17, 1930.
[2] *J. Wash. Acad. Sci.*, 19: 436, 1929.

Several cultures of the nematode have been grown on artificial media for five and one half months, transfers being made every ten days to two weeks. At the end of six months the worms failed to reproduce and the majority died.

During the cultivation of these strains, the nematodes were repeatedly shown to be capable of producing fatal infection in beetle larvae. A culture after six months on media, and which had seemingly lost its ability to grow, was still capable of infecting beetle larvae. The forms obtained from these again produced good cultures.

It is believed that this is the first time that the entire life cycle of a parasitic nematode has been obtained on an artificial medium. The cultivation of this form enables us to obtain worms in large numbers, and may give us a method for the control of Japanese beetle infestation. This possibility is now being investigated in cooperation with the New Jersey State Department of Agriculture.

R. W. GLASER

DEPARTMENT OF ANIMAL PATHOLOGY,
THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
PRINCETON, NEW JERSEY

THE POTATO RUGOSE MOSAIC COMPLEX

In recent years the identity of the virus or viruses causing rugose mosaic of potato has been questioned. Although it has often been suspected and even claimed that this disease is not due to a single virus, this fact has not been definitely demonstrated or clearly explained.

Working in Johnson's laboratory at the University of Wisconsin and using his viruses, the writer has found that the rugose mosaic disease of potato, which is identical with "spot-necrosis" of tobacco, is caused by a combination of two distinct viruses. The "mottle" virus, which is normally present in apparently healthy potatoes of most if not all standard American varieties, is one of the viruses in the combination causing this disease. This virus is readily transmitted by plant extract but not by aphids. The other virus in this complex is readily transmitted by aphids as well as by plant extract. The symptoms of the aphid-transmitted virus on young Havana tobacco plants are often faint; usually only a clearing of the veins and a general flattening of the plant are apparent.

The aphid-transmitted virus may be separated from the rugose mosaic or "spot-necrosis" complex by means of the aphids *Mysus persicae* or *Macrosiphum solanifolii*. The "mottle" virus may be separated from the complex by various means but may also be readily obtained, free of the aphid-transmitted virus, from apparently healthy potatoes. When these two viruses are combined the result is typical "spot-necrosis" on tobacco or rugose mosaic on potato.[1] When only the insect-transmitted virus is inoculated to the American Bliss Triumph potato, for instance, the result is typical rugose mosaic, since the "mottle" virus is already present. On the other hand, if this virus is transmitted to tobacco it will not produce "spot-necrosis," unless the "mottle" virus is artificially introduced. If the "mottle" virus is not present, as is apparently the case in certain foreign varieties of potato, aphid transmission will naturally fail to produce the typical rugose mosaic disease, although artificial inoculation will succeed. This may explain the contradictory results secured with different varieties of potatoes in foreign countries.

KARL KOCH

UNIVERSITY OF WISCONSIN

MICHELSON AND ROWLAND

DR. MILLIKAN'S excellent obituary of Michelson, published in SCIENCE May 22, contains one statement to which exception may be taken, for it seems to do injustice to another man. This statement is that Michelson in 1880 "became the best known American physicist by virtue of his new speed-of-light measurement."

In the decade ending with 1880 Rowland had published his research on the relation between magnetic induction and magneto-motive force in ferromagnetic metals, had during a short stay in Berlin proved experimentally the magnetic effect of electric convection, an achievement which Helmholtz had attempted in vain, had improved upon the British Association determination of the ohm, and had remeasured the mechanical equivalent of heat, thus displacing the value found by Joule. In the year 1880, I believe, and certainly not later than 1881, he had begun the construction of that dividing engine which was soon to make the Rowland concave diffraction gratings universally and permanently famous. These gratings and the measurements he made with them won for him the Draper Medal of the National Academy of Sciences in 1890, many years before the same award was made to Michelson.

EDWIN H. HALL

CAMBRIDGE, MAY 25, 1931

CONSULTANT SERVICE AT THE LIBRARY OF CONGRESS

THE letter published in SCIENCE of January 2 in regard to the new consultant service at the Library of Congress has elicited correspondence, some of which indicates the need of further information as to certain details of the service offered by the library.

[1] After submitting this manuscript for publication, the writer received Kentucky Agricultural Experiment Station *Res. Bull.* No. 309, in which Valleau and Johnson report having reached similar conclusions.

A brief library circular on "special facilities and regulations for research" covers such matters as the assignment of study rooms for the convenience of persons carrying on group or individual research or engaged in advanced work. A special collection of reference books is immediately available and other books are brought from the stacks on application. Access to the stacks is allowed, and to some extent books may be taken away for outside use. There is opportunity for incidental typewriting and clerical service.

A "System of Inter-Library Loans" is defined by a circular letter of July 1, 1930. Such loans rest on the theory of a special service to scholarship by the loan of unusual books not readily accessible elsewhere. Loans to colleges and universities are customarily limited to books required by members of the teaching force in their own investigations. The system is intended to complement the resources of the local library rather than to supply the major part of the material needed for extended research.

Photostat duplication may be arranged on the basis of an official memorandum dated December 10, 1930.

Library of Congress catalog cards may be purchased or ordered by libraries or individuals. These cards have been printed for accessions since January, 1901. The stock of cards now covers about 965,000 titles, is relatively complete not only for books copyrighted in the United States but for a large fraction of the more important foreign publications in the library, whose theoretic field is all literature required for research.

A small pamphlet, "L. C. printed cards: How to order and use them," contains detailed instructions in regard to the manner of ordering cards on any well-defined topic. It is also possible to subscribe for proof sheets, for example, in geography and anthropology, medicine, science, technology. The number of subscribers for cards has increased from about 200 in 1901 to more than 5,000 in 1930, the latter figure including some 600 individuals and firms.

Complete sets of cards are deposited in 51 libraries, a list of which is published in the librarian's annual reports. This, as well as the library classification and subject headings, may be consulted in the principal university libraries of the country.

H. W. TYLER,
Consultant in Science

KOPERNIK

IN SCIENCE for January 17, 1930, Dr. R. L. Sackett writes: "Copernicus was a German who studied in Vienna and Rome. He taught mathematics and for thirty or more years considered the Ptolemaic theory."

This passage is inexact. I hope that you will allow me to give some information concerning the great Polish astronomer.

Nicholas Kopernik, called after the Latin manner "Copernicus," was not a German but a Pole. He was born in 1473 in Toruń, a town situated in Polish Pomerania, taken in 1793, after the second partition of Poland, by Prussia, recovered by Poland in 1920 by virtue of the Treaty of Versailles. For many years this borderland of Poland was the scene of many combats between Polish subjects and the Teutonic order of knights known as the Order of the Cross. Both the father and mother of the astronomer were natives of Upper Silesia, an ancient province of the Polish kingdom. The name of the family is purely Slavonic, being derived from the name of a church village "Kopernik," where it had its origin. The father of Kopernik before settling in Toruń was living in Cracow, then the capital of Poland.

Kopernik, or Copernicus, was educated in Poland, at first in a school in Włocławek, a town on the Vistula, later in the University of Jagiellon, in Cracow. From 1491 to 1495 he studied there theology, mathematics and astronomy. He studied afterwards in Italy, as did many Polish scholars in the fifteenth and sixteenth centuries, ecclesiastical law in Bolonia and Rome, 1496–1501, and medical science in Padua and Ferrara, 1501–1504, but he did not study in Vienna. In the year 1501 he taught mathematics in the Roman Catholic University "Sapienza" in Rome.

After having returned to Poland in 1504, Kopernik was charged with a high ecclesiastical post as a canon of the Roman Catholic church in Frauenberg in the province of Varmia on the western border of Poland. He did not leave this post until his death in 1543. In Frauenberg he wrote his famous book, "De revolutionibus orbium caelestium," published, however, in Nuremberg, through the interest of his admirer and pupil, George Rhetic, professor in the University of Wittenberg.

In his political and social activity the great astronomer gave evidences of his patriotism. He was known as the author of a plan to amend the money circulating in the Polish western provinces. He also in the period of the Polish combats with the Knights of the Teutonic Order commanded in 1520 the defense of the fortress Olsztyn in the province of Varmia.

ST. MICHALSKI,
Editor of the *Nauka Polska*

ERRONEOUS CITATIONS

DR. C. A. SHULL's article appearing in SCIENCE for April 3, 1931, entitled "Erroneous Citations and Titles of Scientific Papers" is very much to the point and has perhaps more force and timeliness than the

writer realized. In the second paragraph can be found in italics, "It is never safe to copy a literature citation from some other author's literature list." Later on, in the same paragraph, by way of illustrating specifically the frequency of inaccurate literature citations the statement is made that "on looking up this citation, I found myself in the midst of a paper by Harden and Young on 'Action of Enzymes on Human Placenta.'"

Becoming possessed with a desire to see such a grievous error illustrated, I turned to page 577 of the Journal of Biological Chemistry, 36: 1918. There, to my astonishment, I found a paper on "Action of Enzymes on Human Placenta" not by Harden and Young, but by Hard*ing* and Young!

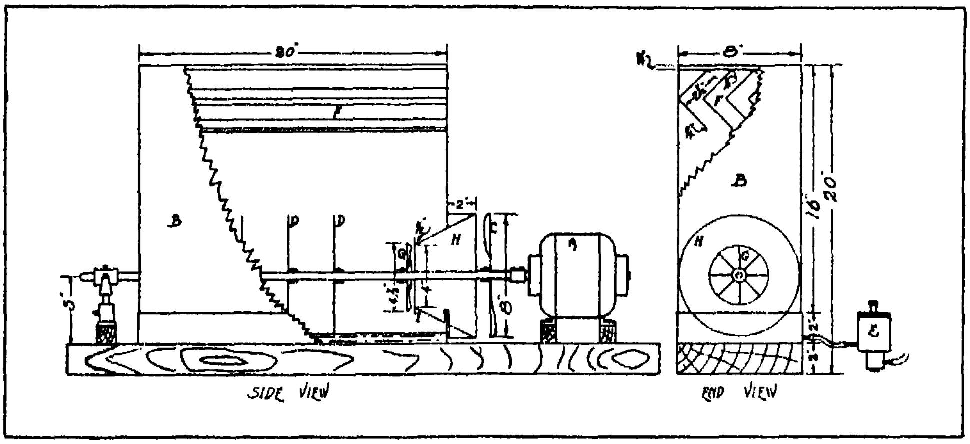
C. W. Ackerson

College of Agriculture,
The University of Nebraska

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE DEVICE FOR HUMIDITY REGULATION

The necessity for an accurate means of humidifying air in incubators, coupled with a limited budget, led to the development of the humidifier described herewith. Since the device is accurate to within ± 2 per cent. relative humidity and may be built complete for approximately $20, it seems worth describing in Science to make it available for others who may have similar needs. The writers hope to publish soon a bulletin containing a more detailed description of the machine together with some of the results that have been obtained from its use.



Briefly its characteristics are: (1) Accuracy not ordinarily attained, (2) simplicity of design with all the advantages attendant thereto, (3) adaptability, (4) cheapness. Operating the humidifier in a closed system, hygrothermograph charts have been obtained showing a line not varying beyond the limits of the 2 per cent. marks during the course of a week. This lack of variation of the hygrograph needle is not due to a lack of sensitivity of the recording mechanism, either, because the needle on the machine invariably dropped immediately when the incubator door was opened. Simplicity of design was attained by attaching the single moving part of the machine directly to the shaft of the driving motor and by the elimination of a hygrostat. A variation in dimensions will allow the machine to be used in any sized incubator. By coupling onto the end of the shaft, humidifiers in adjacent incubators may be operated by the same motor. Simplicity means cheapness, so that the entire mechanism including a ¼ H.P. electric motor may be assembled for slightly less than $20.

The operation of the apparatus as shown in the accompanying drawing is as follows: A continuous-duty electric motor (A) revolving at approximately 1800 R.P.M. forces air into a humidifying chamber (B) by means of a fan (C). Agitator discs (D) made of ¼ inch-mesh galvanized wire screen (hardware cloth), dipping into water at the bottom of the humidifying chamber, beat it violently and throw it into the air as a fine mist, thus raising the humidity of the incoming air. A float chamber (E) from a brass automobile carburetor maintains accurately the water level in the humidifying chamber. Baffle plates (F) in the top of the humidifying chamber prevent particulate water from passing into the incubator with the humid air. To prevent any particulate water from flying back through the entrance, a baffle plate (G) made from a metal disc in the form of a multiple-blade fan is necessary. A cone (H) tapering from a diameter of 8 inches at the fan to 4 inches

in diameter at the baffle disc converges the air stream and passes it through the baffle into the humidifying chamber. A flange (I) one half inch wide soldered to the small end of the cone prevents water from dripping into the opening. The shaft, shaft hanger, coupling, and collars onto which the fan and agitators are soldered are stock parts of the "Driver" home workshop. They may be purchased from Sears, Roebuck & Co. or from the chain store called "Grant's." The shaft should be of brass, but an iron one may be coated with shellac to prevent rusting. The humidifying chamber may be made easily by a tinsmith from galvanized sheet iron.

When the humidifier is operating continuously and temperature is held constant, the relative humidity within the incubator is a function of the depth to which the agitator discs dip into the water of the humidifying chamber. Hence the relative humidity may be varied by raising or lowering the water level. Since the water level in the humidifying chamber is the same as that in the float chamber of the carburetor, the relative humidity within the incubator may be varied by altering the height of the carburetor. From these facts it is obvious that the precision of humidity regulation depends upon the sensitivity of the float and needle valve in maintaining a constant water level. The ratio between unit difference in water level and unit difference in relative humidity in the incubator depends upon the difference between the capacity of the humidifier and the size of the incubator in question. A machine the size of the one illustrated works very satisfactorily in an incubator of 53 cubic feet capacity.

Other methods of varying the humidity output of the apparatus and therefore of varying the relative humidity in the incubator is to alter the number of agitators or to change the size of the outlet through the baffle plates. These methods, however, serve only to alter the capacity of the humidifier. The sensitivity of the float and needle valve in the carburetor remains as the secret to the accuracy of humidity regulation.

GEORGE E. R. HERVEY
JAMES G. HORSFALL
NEW YORK STATE AGRICULTURAL EXPERIMENT STATION

SPECIAL ARTICLES

THE LEAKAGE OF HELIUM THROUGH PYREX GLASS AT ROOM TEMPERATURE, II[1]

SOME years ago (SCIENCE, 68: 516, 1928) Baxter, Starkweather and Ellestad reported evidence of the slow leakage of helium from a sealed pyrex globe containing helium at room temperature. The gas in the (1044 ml.) globe was originally under slightly less than average atmospheric pressure in this locality, *i.e.*, 75 cm. The globe was occasionally compared in weight with a similar sealed globe, containing argon under a pressure of 79 cm., over a period of a year. In the course of the year the helium globe lost in weight to an extent corresponding to a little more than 1 per cent. of the helium.

Date	Excess in wt. of counterpoise over globe g.	Time days	Loss in wt. mg.	Loss in wt. per day mg.
Nov. 11, 1927	8.08873	0		
Nov. 11, 1928	8.09046	366	1.73	0.00474
Feb. 2, 1929	8.09091	449	2.18	0.00486
April 25, 1929	8.09141	531	2.68	0.00505
May 2, 1929	8.09144	538	2.71	0.00505
June 28, 1929	8.09179	595	3.06	0.00515
March 25, 1931	8.09445	1230	5.72	0.00465
May 22, 1931	8.09500	1288	6.27	0.00488
May 23, 1931	8.09491	1289	6.18	0.00479
May 25, 1931	8.09496	1291	6.23	0.00482

[1] Contribution from the T. Jefferson Coolidge Memorial Laboratory of Harvard University.

The weight of the globe has been occasionally determined since that time and the observations show a continuous regular loss corresponding to that previously found.

In the three years and one half since the experiment was started the proportion of helium which apparently has diffused through the glass is nearly 3.5 per cent. (35 ml.). The rate of leakage per day is somewhat irregular although a continuously slower rate is to be expected on account of the diminishing interior pressure.

G. P. BAXTER
H. W. STARKWEATHER

INCREASING THE VITAMIN D POTENCY OF COW'S MILK BY THE DAILY FEEDING OF IRRADIATED YEAST OR IRRADIATED ERGOSTEROL[1]

LUCE[2] in 1924 reported that the diet of the cow appeared to be the main factor in determining the

[1] The experiments here described were carried out through the cooperation of the Walker-Gordon Laboratory Company and Columbia University.

[2] E. M. Luce, *Biochem. J.*, 18, 2379, 1924.

antirachitic potency of her milk. Recently Steenbock and coworkers[3] and Wachtel[4] have shown that the vitamin D activity of cow's milk may be increased several times by supplementing milk-producing rations with irradiated yeast, and Krauss and Bethke[5] have obtained similar results by feeding irradiated ergosterol.

We are briefly reporting here the results of an investigation which was started in April, 1930, and in which both irradiated yeast and irradiated ergosterol were fed and compared as sources of vitamin D for dairy cattle.

Twenty-one Holstein-Friesian cows, each producing more than forty-five pounds of milk daily on a three-time milking schedule, were selected at random for experimentation from among the fresh cows of a large "Certified" dairy herd. They were segregated into seven groups, each of which contained three cows, and produced about the same average quantity of milk. Throughout the experiment, which included a preliminary feeding period of three months and a supplemental feeding period of four weeks, all cows received the same basal ration of alfalfa meal, corn silage, beet pulp and grain mixture. At no time during the experiment did Group I, the negative control group, receive anything except the basal ration and water. During the supplemental feeding period the basal ration of the other six groups was fortified with vitamin D obtained from irradiated yeast and irradiated ergosterol. All cows were confined indoors during the entire experiment except when exercised, to exclude any possible influence of the sun's rays indirectly affecting the antirachitic activity of their milk. They were exercised out-of-doors at midnight in barren corrals.

Throughout the supplemental feeding period each cow in Groups II, III and IV received 10,000, 30,000 and 60,000 rat units per day respectively of vitamin D as irradiated yeast, while each of those in Groups VIII, IX and X received 15,000, 45,000 and 135,000 rat units per day respectively of vitamin D as irradiated ergosterol dissolved in relatively small quantities of corn oil. At the end of the supplemental feeding period equal quantities of milk were collected from each cow during three consecutive days, those from each group being pooled. The butter fats were separated from each composite group sample of milk and carefully filtered at a low temperature to free them from curd, water and salts. These butter fats were then tested for their vitamin D potencies, according to the method described by Steenbock and Black.[6] Several graded levels of each of the butter fats were fed during a ten-day period to rats which had been made rachitic on the Steenbock diet No. 2965. Line tests were made on the radii, ulnae and tibiae of all the animals and the relative values of the different butter fats judged. The vitamin D potencies of the butter fats from the cows fed 10,000, 30,000 and 60,000 rat units of vitamin D in the form of irradiated yeast were approximately 2, 8 and 16 times respectively that of the butter fat obtained from the negative control group, while the vitamin D values of the butter fats from the cows fed 15,000, 45,000 and 135,000 rat units of vitamin D in the form of irradiated ergosterol were approximately 2, 4 and 16 times respectively that of the negative control butter fat. In another experiment to be reported later we have obtained essentially a confirmation of these observations.

While we have demonstrated that diet may very markedly increase the quantity of vitamin D normally occurring in cow's milk, it is equally apparent that some antirachitic supplements may be utilized more efficiently than others by the dairy cow. Steenbock and coworkers[3] state that they have evidence to show that the vitamin D in yeast occurs in at least two different forms. This may possibly account for the different effects produced by irradiated yeast, and irradiated ergosterol. On the other hand, inasmuch as Hart and coworkers[7] demonstrated that eight ounces of cod liver oil daily were poorly absorbed by milking cows it might be argued that in our experiments the ergosterol dissolved in corn oil likewise was poorly absorbed. It should be pointed out, however, that in contrast to the large amount of oil fed by the Wisconsin investigators the largest amount received by any of our cows per day was 90 cubic centimeters, equally distributed in three gelatine capsules, one being fed every eight hours. Furthermore, when compared with each cow's ration of 30 pounds silage, 12 pounds of grain concentrate, 12 pounds of alfalfa hay and 4 pounds of beet pulp, it would hardly be expected that this small volume of oil would interfere with the absorption of vitamin D from the irradiated ergosterol dissolved in it.

The fact that the vitamin D potency of cow's milk can be increased at least 16 times by feeding is important; for in this way milk, with its high content and excellent proportions of calcium and phosphorus, can be made a still better food for the development of the skeletal system.

[3] H. Steenbock, E. B. Hart, F. Hanning and G. C. Humphrey, *J. Biol. Chem.*, 88, 197, 1930.

[4] M. Wachtel, *Münch. Med. Wochschr.*, 76, 1513, 1929.

[5] W. E. Krauss and R. M. Bethke, April, 1931, Meeting, Am. Soc. Biol. Chemists.

[6] H. Steenbock and A. Black, *J. Biol. Chem.*, 64, 263, 1925.

[7] E. B. Hart, H. Steenbock and E. C. Teut, *J. Biol. Chem.*, 84, 359, 1929.

Full reports of these investigations which are being continued will be published later.

BYRON H. THOMAS
FLORENCE L. MACLEOD
IOWA AGRICULTURAL EXPERIMENT STATION,
AMES, IOWA
COLUMBIA UNIVERSITY,
NEW YORK, N. Y.

THE PREPARATION OF ADRENAL EXTRACT

SINCE we have received many requests for the details of our method of preparing an extract of the adrenal cortex, their publication seems desirable.

The medulla contains toxic substances[1] which must be removed if whole adrenals are to be used. We have tried to remove or destroy these substances by washing the ethereal solution with acid or alkali, or by treating the alcoholic or aqueous solutions with aluminum hydroxide, Lloyd's reagent, permutit, kaolin or charcoal. The toxic substances can be removed, but so much cortin is also removed that at present it seems more satisfactory to start with cortex alone.

Fresh adrenal cortex, or cortex from adrenals frozen immediately after killing, is finely ground in a meat chopper. Peroxide-free ethyl ether (a one per cent. $K_2Cr_2O_7$ solution acidulated with H_2SO_4 turns blue in a few seconds after shaking with peroxide ether) is added to the material in a flask as soon as possible. Ether must always be kept in the dark, because peroxides develop within a few hours upon exposure to light. We, therefore, work in a dark room or cover our flasks with opaque cloth. Peroxides destroy cortin and cause toxic substances to develop. A satisfactory proportion for extraction is 4 liters of ether to 3 kilograms of tissue in a 12 liter flask. The air in the flask is replaced with CO_2 and the flask closed with a rubber stopper wired in place. Extraction is facilitated by agitation on a shaker or rocker for four to eight hours. Care must be taken not to produce an emulsion by too vigorous shaking. After pouring off the ether extract, second and third extractions with ether are made in a like manner. The three ether extracts are combined and concentrated almost to dryness by vacuum distillation.

The residue from the ether distillation is extracted four times with 95–98 per cent. ethyl alcohol heated from 45° to 50° C. and kept warm during the extraction so that the fatty material is kept fluid, otherwise the alcohol does not penetrate. For one kilo of gland material about 50–60 cc of alcohol are used in each extraction. One hour on the shaker is adequate for each extraction. The flask is cooled by surrounding with cracked ice so that the alcohol may be easily separated from the oily matter. All fractions are combined and enough water added to make the alcohol content 80 per cent. The solution is chilled to −10° C. ($CaCl_2$ and ice mixture) or below and filtered in a cold atmosphere (4° C. or less) to remove undesirable material. This is extremely important. If the chilling is not sufficient or the solution becomes warmed during filtering, toxic substances are carried through the paper. The alcohol is removed *in vacuo* and the residue again extracted with a small volume of 60–75 per cent. alcohol, then chilled and filtered as above. The alcohol is again removed and the residue extracted with a small volume of ether. The ether is driven off and its residue taken up with sufficient water to make the desired concentration. NaCl is added to make the extract isotonic with the body fluids. After passing through a Seitz filter, the extract is ready for injection.

If the precautions are carefully observed a potent, non-toxic extract can be made. One patient was injected four times daily for more than seven months without untoward effects.

Recently, Britton and Silvette[2] compared our method with that of Swingle and Pfiffner. One of the investigators from Britton's laboratory spent several weeks working with Swingle and Pfiffner,[3] while their knowledge of our method was based only upon the brief published[4] outline of our process. The results of Britton and Silvette are, therefore, what one might expect. Perla and Marmorston-Gottesman[5] have recently used our method successfully. Dr. Perla spent two days in our laboratory.

FRANK A. HARTMAN
K. A. BROWNELL
DEPARTMENT OF PHYSIOLOGY,
UNIVERSITY OF BUFFALO

[1] E. B. McKinley and N. F. Fisher, *Am. J. Physiol.*, 76: 268, 1926.

[2] S. W. Britton and H. Silvette, SCIENCE, 73: 322. 1931.

[3] W. W. Swingle and J. J. Pfiffner, *Am. J. Physiol.*, 96: 153, 1931.

[4] F. A. Hartman, K. A. Brownell and W. E. Hartman, *Am. J. Physiol.*, 95: 670, 1930.

[5] D. Perla and J. Marmorston-Gottesman, *Proc. Soc. Exp. Biol. and Med.*, 28: 650, 1931.

THE LIFE HISTORY OF BABESIA BIGEMINA IN THE NORTH AMERICAN FEVER TICK

Babesia bigemina (Smith and Kilbourne, 1893)[1] is the piroplasm which is the causative agent of Texas cattle fever, a disease that at one time threatened the existence of a cattle industry in the United States. Smith and Kilbourne (1893) demonstrated conclu-

[1] T. Smith and F. Kilbourne, *Bull.* Bur. Animal Industries, U. S. Dept. Agr., Washington, 1: 177–304, 1893.

sively that *Babesia bigemina* is transmitted from host to host only by the agency of *offspring* of female ticks which had previously fed upon the blood of cattle which at the time of feeding were suffering, or had recovered, from an attack of Texas fever. *Margaropus annulatus* (Say) is the obligatory vector of this protozoan parasite in North America, and the life history of *Margaropus*, a one-host tick, makes the life history of *B. bigemina* inseparable from the developmental cycle of the tick.

Ticks for this investigation were collected by the writer from dairy cattle east of Texarkana, Arkansas, during the summer of 1928, from near Abbeville, Louisiana, in July, 1929, and a bountiful supply has been provided through the courtesy of Dr. C. W. Rees, of the zoology division of the Bureau of Animal Industry, Iberia Experiment Farm, Jeanerette, Louisiana. The observations reported here were made on two series of ticks: (1) the gut contents, organs, ova, embryos and newly hatched larvae of female ticks which had fed on the blood of a bull suffering from an acute attack of Texas fever; (2) a similar series of control ticks reared on a mule to clean them, and on clean susceptible steers for three subsequent generations. The bites of larvae belonging to series No. 1 produced the disease in a susceptible animal, the host reacting on the fourteenth day after being infested.

The parasites were studied in fresh saline preparations, smears and sections.

The most complete set of observations on the life cycle of a piroplasm heretofore published is the work of Christophers (1907)[2] on the life cycle of *B. canis*. A preliminary report on the life cycle of *Theileria parva* was recently published by Cowdry and Ham (1930).[3] Several of the forms described by Christophers as stages of *B. canis* appear also in the development of *B. bigemina*.

The sexual phenomena and sporogony of *Babesia bigemina* take place in the tick. The early phases occur in the lumen of the gut after the ingestion of parasitized blood.

1. Examination of gut contents reveals: (*a*) typical trophozoites (Dennis, 1930)[4] that have recently been taken into the gut and which may be free in the ingested mass, or may be incorporated in the wandering digestive macrophage cells of the tick; several may accumulate in a single macrophage. Parasites that are so phagocytized are soon digested. Pear-shaped and rounded forms of the parasites are observed free in the gut. (*b*) A leaf-shaped form of the parasite that is quite abundant. This form stains poorly and is believed to be degenerate. (*c*) There is present a very characteristic club-shaped form. These bodies are *isogametes*.

2. The gametes are club-shaped parasites about 5.5 to 6.0 μ in length. They arise by growth and modification of structures from certain trophozoites that are indistinguishable from other trophozoites. The male gametes are not distinguishable from the female gametes. These sexual forms are actively motile.

3. Fertilization apparently takes place by the isogametes becoming associated first at the blunt anterior end, and then fusing. Syngamy results in the formation of a motile zygote or oökinete which soon leaves the lumen of the gut.

4. The öokinetes penetrate the tissues of the thin gut wall where they may round up, grow and form *sporonts* ranging from 5.0 to 12.0 μ in diameter, or they may pass completely through the gut wall and enter the ovary where they invade the ova.

5. In the ovum the oökinete also forms a sporont, which then divides to form multinucleate "sporoblasts." These sporoblasts are amoeboid and actively motile, and migrate throughout the embryonic tissues of the developing tick. Because of their migratory nature these somatellas are called *sporokinetes*. The sporokinetes are very pleomorphic and have from four to about thirty-two nuclei. During the ontogeny of the tick the sporokinetes may come to infest almost any tissue of the embryo.

6. Since much of the anterior embryonic cell mass of the tick is destined to contribute to the salivary glands, some of the alveoli come to be occupied by sporokinetes. As the incubation period of the tick draws to a close, some of the sporokinetes undergo multiple fission or "sporogony" to form *sporozoites;* others may not form sporozoites until after the tick has hatched.

7. The sporozoites are miniature trophozoites, and may also multiply, doing so by the "budding" process which is characteristic of the trophozoite. The sporozoites are inoculated into the blood stream of the bovine host in the saliva of the feeding seed-tick, and soon set up an active infection of the erythrocytes of the host.

The writer wishes to express here his sincere thanks to the kindness and generosity of Dr. Rees, who provided material of known infectivity and lineage, and to Professor C. A. Kofoid, of the Department of Zoology, University of California, at Berkeley, under whose supervision this research has been carried on.

EMERY WESTERVELT DENNIS

UNIVERSITY OF CALIFORNIA
AT LOS ANGELES

[2] S. R. Christophers, *Scient. Mem. Govt. of India*, n. s., 29: 1–83, 1907.

[3] E. V. Cowdry and A. W. Ham, SCIENCE, 72: 461–462, 1930.

[4] E. W. Dennis, Univ. Calif. Publ. Zool., 33: 179–192, 1930.

CALCIUM ARSENATE AND UNPRODUCTIVENESS IN CERTAIN SOILS[1]

THE economic necessity of combating the constantly increasing number of insects that attack crop plants has resulted in the employment of increasing quantities of insecticides. For control of the cotton boll-weevil, calcium arsenate dust is commonly used in amounts varying from 20 to 50 pounds an acre annually. Therefore, relatively large amounts of arsenic are added to the soil in a comparatively short time.

It is beyond the scope of this paper to review studies of the physiological effects of arsenic upon plants except to mention that it is well established that appreciable concentrations of soluble arsenic in the medium in which plants are grown are more or less toxic. Observations with a Norfolk fine sandy loam soil at Florence, South Carolina, show that frequent applications of calcium arsenate dust for boll-weevil control over a period of years may render such soils unproductive for certain crops. It has been found extremely difficult, except under highly favorable seasonal conditions, to obtain normal appearing cotton, oats and cowpeas when the preceding crop has received these frequent applications.

Soil that contained thirty parts per million of arsenic and which would not produce a normal growth of cowpeas and oats was transferred to a greenhouse soil bed. A soil of similar type containing eight parts per million of arsenic and which would produce a normal growth of cowpeas and oats was used as a check. Oats and cowpeas were planted and at about the time of maximum vegetative development samples of roots and tops were obtained and subsequently analyzed for some of the minerals. The data pertaining to the arsenic content in parts per million on a dry weight basis are presented in Table 1. In all cases the concentration of arsenic in the tops and roots was appreciably higher in the plants grown on the high arsenic soil although the tops had much lower concentrations of arsenic than did the roots.

Portions of soil from the low arsenic bed were then treated with calcium arsenate at the rates of 200 and 400 pounds per acre and, after being allowed to stand for one week, were planted to cowpeas. Marked differences in germination and rates of growth were apparent after four days and most of the seedling plants in the treated beds died within two weeks. Arsenic analyses of the roots of seedling plants ten days after planting showed a content of 25, 288 and 330 parts per million in the untreated, 200 pounds, and 400 pounds per acre applications of calcium arsenate, respectively.

[1] Technical contribution No. 4 (new series) from the South Carolina Agricultural Experiment Station.

Various salts were added to an arsenic treated soil in collodion sacks and the diffusates analyzed for soluble arsenic. Calcium carbonate and certain iron salts were the only electrolytes used that decreased the arsenic in the diffusate. Greenhouse and field tests with sufficient amounts of calcium hydroxide to neutralize the soil acidity indicate some improvement in this condition.

It has been noted that cowpeas grow in a normal manner on virgin forest soil and on red clay soil to which calcium arsenate has been added. This suggests that the arsenic fixing power of soil is associated with its organic matter and colloidal contents.

A heavy growth of various forms of algae and fungi were observed in these unproductive soils. Studies on the possibility of soil micro-organisms reducing arsenates to the more toxic compounds are in progress.

The observations and data presented definitely indicate that the addition of large amounts of calcium arsenate to gray light sandy loam soils may be expected to interfere seriously, sooner or later, with the subsequent growing of such arsenic sensitive crops as cowpeas, oats, cotton, and various grasses.

TABLE 1

ARSENIC CONTENTS OF OATS AND COWPEAS GROWN ON SOILS CONTAINING HIGH AND LOW AMOUNTS OF ARSENIC

Arsenic contents of soil in p.p.m.	Arsenic in p.p.m.			
	Oats		Cowpeas	
	Roots	Tops	Roots	Tops
30	180	6	40	11
8	80	3	10	3

W. B. ALBERT
W. R. PADEN
SOUTH CAROLINA EXPERIMENT STATION

BOOKS RECEIVED

FOX, DIXON R., editor. *A Quarter Century of Learning.* Pp. 380. Columbia University Press. $3.50.

FRAPRIE, FRANK R., and WALTER E. WOODBURY. Photographic Amusements. Tenth edition, revised. Pp. viii + 271. 180 figures. American Photographic Publishing Company. $3.00.

LENNES, N. J. *Differential and Integral Calculus.* Pp. xiii + 471. Harper's. $3.00.

SEWARD, A. C. *Plant Life through the Ages.* Pp. xxi + 601. 140 figures. Cambridge University Press, Macmillan. $10.00.

SHAW, CHARLES F. *The Soils of China.* Pp. 38. Geological Survey of China, Peiping.

THURSTONE, L. L., and RICHARD L. JENKINS. *Order of Birth, Parent-Age, and Intelligence.* Pp. xiii + 135. University of Chicago Press. $3.00.

SCIENCE

VOL. 73 FRIDAY, JUNE 12, 1931 No. 1902

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

QUALIFICATIONS OF A RESEARCH PHYSICIST[1]

By Dr. ALBERT W. HULL

GENERAL ELECTRIC COMPANY

I AM going to show you, later, that the figure of merit of a research physicist is expressible in degrees of ignorance rather than knowledge. My first application of this theorem is the willingness, or temerity, to address you upon this subject, about which you know so much more than I.

Please note the narrowness of the subject. Research physicists are a small class—perhaps too small to be called a class. They are a part of the so-called creative group, which is rated at the top of the human ladder by certain students of society such as Dr. Charles R. Gow[2]; and by certain others as akin to the mentally unbalanced. Whether high or low doesn't concern us here. I am merely leading up to the first qualification of a research physicist, which is that he must be born that way.

The aptitudes with which a man is born determine, often uniquely, his field of successful activity. By field is meant, not a specified profession, but some one of a group of related activities which utilize the same qualifications. The most common classification recognizes three types of native ability: the research type, the engineering type, and the executive type. Sometimes the research and engineering types are classed together and a teaching type differentiated. For example, President Hadley[3] summed up these qualifications for Yale undergraduates as follows:

> Speaking broadly, men may be divided into three types or temperaments: the scientific type, consisting of men whose power lies in observing and arranging and put-

[1] Address presented before the American Association of Physics Teachers, Bureau of Standards, April 30, 1931.

[2] Charles R. Gow, "Foundations for Human Engineering," Macmillan, 1930.

[3] A. T. Hadley, "Choosing a Career," *Yale Alumni Weekly*, March 3, 1916.

ting facts in order; the literary type, whose interest lies in communicating ideas to others, and in thus influencing the opinions and actions of their fellow men, and the practical type, which is interested neither in the arrangement of facts nor in the communication of ideas, except as a means of achieving concrete results in the way of business or politics or some form of human endeavor. From the first type come our physicians, our engineers, our accountants, and our consulting experts of every kind. From the second type come our teachers, our preachers, our journalists, and our jury lawyers; from the third, our merchants, our manufacturers, our railroad men, and our consulting lawyers.

It is preferable, I think, to differentiate the research and engineering types, since both the temperament and the training required for these two fields are fundamentally different, as will be shown later.

The point to be observed is that each profession utilizes certain inherent powers. If a man is endowed with these powers in a high degree he can be highly successful; if in small degree, his success in this profession will probably be small, in proportion to his low starting-point.

O'Connor,[4] who has applied the methods of research physics to the personnel problem, has devised some excellent tests for mechanical aptitudes, and has used them to measure the effect of training upon these aptitudes. He finds that repetition of a given operation increases the speed with which both good and bad operators perform this operation to about the same extent, so that their relative standing remains unchanged; but that this practice does not increase the ability of either to perform a similar but slightly different operation.

For example, two girls, who originally required 12 and 6 minutes respectively to pick up 300 pegs, improved with practice until, at the 30th trial, their times were 8 and 4 minutes, respectively. The ratio remained 2 to 1. Twenty girls were selected and divided at random into two groups. After an initial test, which showed the same average time for each group, one group was given two weeks training in a different task, similar to the first except that tweezers were used instead of fingers. Upon repeating the original test the two groups were found to be still equal. Similar tests extending over a period of years instead of weeks led to the same conclusion. Considering the variety in the work of a physicist, these examples teach that the clumsy manipulator will probably remain so through life.

A second test, which is applicable to physicists, is designed to measure the power of space-visualization. It consists in the assembly of a dissected block. Two college room-mates, graduates of a technical school, required 30 sec. and 30 min. respectively to perform this test. Upon repetition the first maintained his 30 sec. record, but could not improve it, being limited by the time required for manipulation; while the second gradually improved until, after 20 repetitions, he equalled the first. The two were then given another block, identical with the first except that it was half as large. The first man assembled it in 30 sec., the other required 20 min. The difference between these two men is not in manipulative skill, for both were equally fast when they knew what to do; but in space sense, one of the prime requirements of a research physicist.

I would like to emphasize still further the importance of these native aptitudes and the degree to which they are unchanged by training.

A prominent executive has rated his engineers, some two thousand in number, according to their performance in their particular fields, designating each by a number. That is, a first-class man in any field would be rated 100, etc. Independent ratings were made by three different observers from different departments, and these were compared with the relative standing of the men in the company, as evidenced by their salaries. In only 2 per cent. of the cases were the differences between these four ratings as great as 5 per cent. Moreover, when these relative ratings were compared with the previous standing of the same engineers over a period of years, it was found that they had changed very little.

These results are significant. They indicate that the chances of a man's success in a given field are determined by qualifications that are fundamental and not easily changed. Whether these inherent traits are hereditary or are acquired early in life is immaterial for the present purpose. In either case, they are firmly fixed by the time the young man presents himself at the college gates.

I have recently had occasion to observe the work of two individuals, one a college graduate and the other a boy of 13, whose space-visualization is so vivid that they connect up the most complicated networks with extreme rapidity and close the switch with confidence. I have never known either to make a mistake. Contrast the future outlook of these men, in the field of experimental research, with that of another, who, in spite of an excellent college and teaching record, charming personality and earnest effort, always had at least one wrong connection, and after two years' trial was pronounced a failure at research work. It was observed that this man was a good contact-maker, and, fortunately, a position was found for him where he could utilize this quality, with his general scientific training as a background. He is now extremely successful and happy.

[4] J. O'Connor, "Born That Way," Williams and Wilkins, Baltimore, 1928.

Not only must the research man have the necessary aptitudes, but he must have no extra ones. O'Connor has called attention to this fact also, and has given many examples which show that unused aptitudes produce dissatisfaction and half-heartedness. For example, a man who makes social contacts easily and enjoys doing so is not likely to be content with the quiet life of a research worker. O'Connor concludes,[5] "The larger the number of gifts, the greater the ultimate goal gained, but, all too often, because of the uneasiness engendered by unemployed aptitudes, the gifted man, wasting year after year, ultimately ends as a failure." You all know such men.

The research worker should therefore be endowed with a retiring personality, in addition to mechanical aptitude or power of space-visualization, analytical ability, and, preferably but not necessarily, manual dexterity. To these we may add the health qualities, energy and enthusiasm, without which all success is circumscribed.

These considerations affect vitally the question of the training of physicists. We can not inculcate or cultivate appreciably the aptitudes that make a physicist possible. We can only add to them certain attitudes and habits and a small store of facts. Without the inborn aptitudes, our trained physicist is like an over-rigged ship, destined to flounder. But what harm? Will not the ship, taught by experience, repudiate its rigging and become eventually a useful and succesful barge? The answer of experience is that in most cases it will not. The unsuccessful graduate seeks still more training in the hope of compensating his handicaps, and so builds ever higher the barrier preventing his escape. The emphasis placed upon science during the last ten years has led some to think that it is better to be a poor physicist than a good mechanic. Such belief leads to tragedy. The good mechanic is a happy, self-respecting, indispensable member of industrial society; the man who feels that he is unsuccessful, be it in science or any other field, is destined to a life of dissatisfaction and unhappiness, and of questionable usefulness. The heart-aches of these men are at your doors, if you have given them the training that thus unfitted them for life.

I have emphasized this question of aptitudes because I believe it is the first duty of every teacher to test and advise those who come to him for training. Satisfactory tests are not at present available, but can be discovered by the same methods which are unraveling spectra and nuclei, the methods of research physics. A beginning is being made, notably at Columbia, Iowa and Ohio State universities. One of the most hopeful signs is the growing custom among graduate schools of canvassing the universities for men with graduate qualifications, and canvassing by industries for men with engineering, accounting and salesmanship qualifications. These canvassers choose wrongly about as often as rightly to-day, because of the lack of proper tests. We can do no greater service to our young men than to assist the development and use of these tests.

Assuming that we have chosen our men, what can we teach them? Not very much, if we accept the opinion of some 1,500 engineers to whom Dr. C. R. Mann, of the Carnegie Foundation, addressed the question: "What are the essential qualities of a successful engineer?" The replies showed an average estimate of:

41 per cent. character
17.5 per cent. judgment
14.5 per cent. efficiency
14 per cent. understanding of human nature
13 per cent. technical knowledge

Assuming that the student's advancement in character, judgment, efficiency and understanding of human nature is no more rapid in college than it would be elsewhere, this means that college training, if perfectly successful, can supply only 13 per cent. of the qualities which an engineer needs, according to the judgment of his peers.

The requirements of a research man are different from those of an engineer. In particular, knowledge is of even smaller relative value. I have no questionnaire to quote you. Instead, I will quote the opinion of one of the greatest research leaders, Dr. W. R. Whitney: "The asset of engineering is exact knowledge. The valuable attributes of research men are conscious ignorance and active curiosity."

In these words he characterized the difference between research and engineering for a group of engineers.[6] It reads like a chemical formula. "The asset of engineering is exact knowledge. The valuable attributes of research men are conscious ignorance and active curiosity."

Do you accept this analysis? It is to be assumed that these qualities are in addition to innate aptitude and the undefinable group known as character, and that the list is purposely incomplete. For the present purpose it is sufficient to agree that conscious ignorance and active curiosity are *among* the most valuable attributes of a research man, and that exact knowledge is not among them.

If you agree, then I would like to ask the question: Are we teaching or can we teach these qualities? We have schools reputed so learned that you can

[5] J. O'Connor, *loc. cit.*, p. 204.

[6] W. R. Whitney, "Stimulation of Research in Pure Science." SCIENCE, 65: 285–9, 1927.

always tell their graduates, but can't tell them much. Have we any that teach conscious ignorance?

The value of this attribute may not at first sight be apparent. Apart from the fact that the know-it-all graduate is unbearable to others, is unwilling to stoop to the task for which he is fitted, and is largely immune to further learning, there is a very special significance to research workers of this attitude of conscious ignorance. *If you know the answer beforehand you will always find that your experiments yield that answer.* You are all familiar with examples of this type, some glaring and obvious, hence comparatively harmless, others difficult to detect, stumbling blocks of science. Our journals are full of theses of students who conclude, quite without evidence, that their professor's theory was correct. Such professors are guilty, in some degree at least, of scientific homicide. Unwittingly, but just as surely, they are killing the scientific honesty of their students. Two glaring cases of such self-deception have come to my attention recently, neither of which is as yet known to the scientific world, and perhaps never will be, but will remain as stumbling blocks. What will become of the authors?

Conscious ignorance is a negative quality and becomes dynamic only when joined to active curiosity. Dr. Whitney is fond of the story of the land turtle, whose curiosity led him to leave the water in search of wider experience, and as a result he not only lives better, but has developed a brain, whereas the water turtle has only the rudiments of a brain.[7] It may be more than a myth that the elephant who couldn't restrain his curiosity and wears an elongated nose in token of it developed into one of our most intelligent animals, while the ichthyosaurus is extinct.

Active curiosity looks for the facts behind the formulas. Ask the average physicist why water rises in a small tube and he may answer, "Because of capillarity." The average chemist will probably tell you that the reason iron doesn't dissolve in strong nitric acid is because of its passivity. Has he added any information in substituting his long word for your short one? If our curiosity is of the kind that is satisfied by a name, it will not lead us far.

I think we may agree that active curiosity, curiosity that not only craves to know and is unsatisfied by names or authority, but does something about it, is one of the most valuable attributes of a research man. Dr. Whitney puts it first. He says[8]: "The most important function of colleges and universities is appreciating inquisitiveness and stimulating research."

If we thus agree, we may analyze our methods of teaching from this view-point, and we need not be surprised if we find that they are unsuited. Our educational system has grown up around the basic idea that knowledge is the magic key to life. As the field of education expanded we have continued to apply the same principle and the same methods. It would be surprising if, in this expansion, we did not find some fields where other objectives and other methods were more important, or arrive at a time when knowledge is a sufficiently common commodity to be within the reach of all who know how to value it. In this case the attitude, the will to find out, becomes the key.

Let us consider the question of lectures from the standpoint of training a research physicist. Is the best lecturer one who explains so lucidly that you are left with a comfortable feeling of understanding, or one who, out of the fullness of his experience, opens out before you the unattainable yet challenging expanse of the subject?

I must leave the answer to you with one suggestive example. Several years ago I listened to a lecture by Sir William Bragg on a subject about which I knew nothing. During the discussion I inquired if he had found a relation between crystal structure and magnetism, and he replied with his charming simplicity, "No, we haven't been able to get the crystal structure of iron. We have some measurements but we can't make much out of them." The next year found me deep in x-ray crystal structure research, trying to find the structure of iron.

With this same objective in mind, of teaching attitudes rather than facts, what is your opinion of textbooks as compared with original sources, or of assigned reading as compared with assigned subjects, or of assigned subjects as compared with assigned problems or experiments?

It is said of the great Agassiz that his invariable practice was to give his students as a first assignment a specimen of something, a fish or a flower, and leave them for three days with absolutely no instructions except to observe.[9]

I have been asked to comment on the kind of training desired for industrial research. For many reasons, I should prefer to follow the advice of President Jewett,[10] to discuss only the qualities desired, leaving to those better qualified the question of matter and methods. I will, however, transmit without comment two suggestions received, the first representing the opinion of three engineering executives, that "training in fundamentals is more useful than in specific subjects"; the second from a prominent

[7] C. J. Herrick, "Brains of Rats and Men," Chicago University Press.

[8] W. R. Whitney, "Stimulation of Research in Pure Science." SCIENCE, 65: 285–9, 1927.

[9] Charles R. Gow, *loc. cit.*, p. 116.

[10] F. B. Jewett, "Modern Business Looks at Secondary Education." *School and Society*, 31: 415–19, 1930.

director of research, who makes the following comments:

> Graduates in electrical and mechanical engineering are generally more adaptable than physicists to the problems of industrial research and development relating to physics. They more readily adapt themselves to the handling of apparatus and equipment and are usually more successful in the use of their hands. They have in general a better physical insight and a greater appreciation of practical requirements for carrying through a developmental program.
>
> It probably does not make a great deal of difference what specialized type of training is received by a certain few men with a natural inclination to industrial problems.
>
> We do feel however that too little stress has of late been placed upon the fundamental physics by most American universities, especially in graduate work. The universities are producing physicists who apparently are well qualified to publish worth while researches in spectroscopy and atomic structure, but who have had almost no training in basic mechanics, hydrodynamics, electrical theory and thermodynamics, such as was taught thirty years ago. We believe that in an industrial laboratory, the physicist or engineer who has the fundamental classical background is of greater value than a physicist who has almost exclusively specialized in the modern physical developments.

The qualities that are desirable for successful life are many. Some must be inborn; others, such as attitudes, habits, skills and facts, may be taught. Each combination of qualities fits a man for certain activities.

The qualifications of a research physicist, as I have pictured them, consist mainly of aptitudes and attitudes. The essential aptitudes are, first, a space-sense that will enable him to devise tests, and, second, a retiring personality that gets pleasure from quiet accomplishment, without the need of public applause. The attitudes are, first, an open mind, more anxious to learn the truth than to show its knowledge, which I have called conscious ignorance; and, second, active curiosity, intent on finding out, nerved to spurn delights and live laborious days for the thrill of discovery at the journey's end. President Jewett, of the Bell Laboratories, calls this the spirit of romance. "The thrill," he says, "of adventuring forth intellectually into the unknown and of charting out there paths which others can follow, is equal to that of him who looks on a new land for the first time; and the number of such journeys that can be taken is limitless."[11]

Consciousness of ignorance, combined with active curiosity, is the spirit of youth. Beware of the man who tells you, "I did that 20 years ago." He is old. He is through, either as investigator or as useful teacher.

If knowledge and experience, culminating in judgment, are incompatible with conscious ignorance, then we are better research men without judgment. I believe they are not incompatible. Conscious ignorance and active curiosity are attitudes which may be caught like contagions, cultivated like choice flowers, and retained to old age. We may be young in attitude, though old in experience. To the spirit of youth each observation is a romance, a revelation. This is the spirit of research.

It is in this spirit that we may hope to see the vision of a still greater science. In the words of Dr. Whitney:

> We ought to realize that there may be a more valuable use of knowledge and truth than commercial developments, and by aiming at the full appreciation of creation we may do more than simply conquer and control our local environment. Perhaps industrial uses of new knowledge are after all only by-products or ways of advancing to something better.
>
> We advance more often by finding in Nature that which we may learn to use than by making or forcing from Nature that which we think we want.

THE PROGRESS OF ROENTGENOLOGY AND ITS CONTRIBUTION TO MEDICAL SCIENCE[1]

By the late Dr. PRESTON M. HICKEY

DR. G. W. C. KAYE prefaces his recent monograph with this passage from Hamlet:

> Come, come, and sit you down; you shall not budge;
> You go not till I set you up a glass
> Where you may see the inmost part of you.
> (*Act III, Sc. 4*).

Little did Shakespeare's world realize that in Hamlet's comment to his mother lay the story of a present-day miracle.

[1] Read before Section N, the American Association for the Advancement of Science, January 1, 1930, by Carleton Barnhart Peirce, A.B., M.S., M.D., of the University of Nebraska College of Medicine.

"I regret most sincerely that illness prevents my former preceptor, Dr. Preston M. Hickey, from reading the paper to you. I appreciate more than words can express the honor of presenting for him the initiatory paper of the American Roentgen Ray Society upon its affiliation with the American Association for the Advancement of Science."

[11] "Research and the Individual," *Bull. of Purdue Univ.* 26, July, 1926.

The observations of William Conrad Roentgen, professor of physics at Wurzburg, crystallized in large measure the preparatory researches of Hittorf, von Helmholtz, Hertz, Lenard, Crookes, and their colleagues in the study of electrical discharges through partially exhausted gas tubes.

This paper, signalizing the recent admission of the American Roentgen Ray Society to affiliation with the American Association for the Advancement of Science, comes at the close of thirty-four years since the discovery of a hitherto unrecognized form of energy by Dr. Roentgen on November 8, 1895.

There appeared in SCIENCE for January 24, 1896, the following news note[2]:

> The *Vienna Presse*, the *London Standard* and other daily papers report what purports to be an extraordinary discovery by Professor Röntgen. It is claimed that he has found that the ultra-violet rays from a Crookes' vacuum tube penetrated wood and other organic substances, whereas metals, bones, etc. are opaque to them. It is said that he has thus photographed the bones in the living body, which would be one of the most important advances that has ever been made in surgery. The photographs have been sent to Vienna and are in the hands of Professor Bolzmann, who has, it is said, accepted the discovery, though he has not succeeded in his attempt to repeat the experiment. In spite of apparently absurd statements concerning the action of the ultra-violet rays it is not impossible that substance such as metals which are good conductors of heat should absorb the ultra-violet rays, while substances such as wood, which are bad conductors of heat, should transmit them. Professor Röntgen is professor of physics at Wurzburg, and any experiments published by him should be accepted without hesitation.

The announcement was followed by much discussion and occasional bitter argument among physicists and investigators the world over. Among the Americans were notably Michael Pupin, Henry W. Cattell, Edwin B. Frost, Thomas Edison, Arthur W. Wright, Arthur W. Goodspeed, Ogden Rood, and William J. Morton. Some fifteen articles in SCIENCE during the first six months of 1896 were devoted to the x-rays. In addition during the same period, the lay magazines, such as *McClure's*, published extensive stories of this new adjunct of science. As occasionally befalls to-day, this development in the field of pure science obtained earlier and, at first, more notice in the lay press than in the scientific.

You are aware, of course, of the vast development and enlargement of the sphere of roentgenology since then. You also are undoubtedly aware of its varied employment to-day in the physical field with the development of crystallography and its allied phases. More recently, the Roentgen rays have come to be used in the fields of industry and the arts; for instance, in testing fine machines for flaws in metal parts, the consistency of alloys, fine gems in the lapidaries' hands, and the detection of spurious old masters among oil paintings.

But from its inception the major field has been that of the medical sciences. Dr. Roentgen included in his original communication in the *Sitzungsberichte der Wurzburger Physik medizinische Gesellschaft* a note on the observation of the bones of the hand through the flesh. And yet many physicians of that immediate period expressed grave doubt of its usefulness.

The present occasion we consider as a recognition of the importance of roentgenology as a scientific aid in the study, diagnosis and treatment of disease in the human animal. The medical student, who employs the aid of light and sound in the study and treatment of disease, has always paid a tremendous tribute to the importance of the microscope and the stethoscope. These aids, in turn, perhaps unfortunately we venture to say, are beginning to be surpassed by the important applications of the Roentgen ray.

The development of this special adjunct has in large measure been along two lines; one, the refinement of apparatus and technique for the purpose of better differentiation of the nicer gradations in tissue density, and the control of dosage; the other, in the interpretation of the skiagraphic or Roentgengraphic images obtained. In the former we have had the cooperation of the physicist and engineer, and are well launched on a study of biological effect with the collaboration of the biophysicist. In the latter, we must keep closely associated with the fundamental medical sciences of anatomy, physiology and pathology, especially. Perchance we may be able to link more closely morphology and function, under normal and abnormal conditions, than has been accomplished under the current tendency toward compartmentalization of knowledge and "education."

The close relation to anatomy needs little elaboration. One must have primarily the fundamental structure of embryology and anatomy, both microscopic and gross. We are all aware of a certain shock to our freshman ideas of the placement of the stomach as gained from the cadaver, when we observe under the screen an elongated "fish-hook." This is often the occasion for the exclamation of the novice, "Oh! Oh! J-type!"—a sudden realization that "live" anatomy—or a functioning anatomical structure—is not exactly that of the cadaver and has a wide normal variant. In some laboratories, Roentgen studies are being used more and more to afford the student a sense of regional and functional anatomy, which he

[2] SCIENCE, New Series III, No. 56, January 24, 1896, p. 131.

can not procure from his cadaver. This should include both a study of skiagrams of the parts under dissection and fluoroscopic demonstrations of the thorax and gastro-intestinal tract to small groups by a Roentgenologist.

One hesitates perhaps to urge more of this in the purely anatomical laboratories. The physiologist may feel perhaps that all functional observations should be within his department. We wonder if the majority of our colleagues attempting the instruction of students would not welcome an opportunity to assist the anatomist and the physiologist in demonstrating to the student that anatomical parts are related to each other, and that muscles not only contract on stimulation but move other parts in the process. Furthermore, our information of the growth of the individual, his ossification and subsequent decalcification with age has been increased definitely with the Roentgengram.

Here we must of necessity indicate the relatively inseparable juncture with pathology—pathologic physiology, if you will. For the Roentgenscope and skiagram can offer in large measure the clairvoyance of the necropsy without loss of life of the subject. This clairvoyance is somewhat prognostic—but is essentially valuable in the determination of the past insults of disease heaped on the individual human. One might cite pulmonary damage as a facile example.

Diseases of the respiratory tract, both acute and chronic, may be considered particularly amenable to x-ray examination. The gross tissues of the lung are rendered especially suitable for Roentgen studies because they usually include a graphic background of air. The resultant contrasting shadows emphasized by this background of air demonstrate the density of the gross tissues as well as their relative contour. The x-rays thus bring out the subtractions from, and additions to, pulmonary densities which we have learned differentiate the fine degrees of normal and abnormal tissues. A most important characteristic of this examination is that while the microscope requires a microtome and very thin sections of tissue, the x-ray employs optical sections, leaving the patient intact.

The study of the lungs by means of the x-ray had its beginning in America with Dr. Francis Williams, of Boston, whose early publications on this particular subject date back to 1896 and 1897. Naturally there has been a constant accumulation of new data and new methods of technique. Herein lies a necessarily close correlation of the observations of the clinician, radiologist, and pathologist. One of the very puzzling features in the x-ray study of the chest has been the difficulty of early diagnosis of tuberculosis in children. The early diagnosis of tuberculosis in adults has been very well studied and the characteristic appearance has become quite well known. This is due to the fact that adult tuberculosis is more consistent or typical in its x-ray findings than is tuberculosis in children, where the Roentgen shadows are not so distinctive. It is with pleasure, therefore, that we call attention to the recent work that has been done at the Phipps Institute for Tuberculosis, in Philadelphia. The studies at this institute have added very much to our knowledge of the behavior and appearance of childhood tuberculosis, and in this way has increased our certainty of early diagnosis.

The technique which has been useful in bringing out these helpful points requires the close cooperation of the electrical engineer, and the physiologist, with those already noted above. For it requires the development of a method which will permit very rapid exposures of the chest timed to conform to a particular phase of the cardiac cycle, a mechanical refinement to trip the switch at nearly identical phases. Formerly exposures were made quickly but without being able to choose the cardiac systole or cardiac diastole. We are not able to compare skiagrams made in different parts of the respiratory and cardiac cycles for the reason that the density of the lung shadows depends somewhat upon the quantity of blood in the pulmonary vessels at each different phase of the cardiac cycle. By this we mean that with such refinement of engineering the x-ray exposure can be made either in cardiac diastole or cardiac systole and the changes with the different parts of the cycle can be compared.

Another technical development which has helped much in the study of these cases is the lateral and oblique views of the thorax. The importance of this study, also developed at the Phipps Institute, lies in the opportunity to visualize more clearly the changes in the abnormal bronchial tree, which is usually hidden by the heart shadow, and compare the abnormal with the appearance of the normal. These refinements of x-ray diagnosis in the study of child tuberculosis are destined to be of very great importance as they are compared and studied in the light of pathologic physiology.

Such carefully controlled studies, which must be made, can offer to the fundamental fields of anatomy, pathology and physiology much information, and to clinical medicine a major opportunity for early diagnosis and adequate treatment of such diseases.

Further, in the consideration of progress in the medical sciences, particularly as related to pathology, one must give emphasis to the forte of Roentgenology in the cancer problem. It is perhaps a truism to remark that cancer is the most important medical

problem which we have to face. Students of cancer are all pretty much in accord with a second truism; namely, that success in the battle against cancer necessitates early diagnosis. We may be permitted to say further, that for this early diagnosis the x-ray is probably our most important agent. Even cursory perusal of the statistics would reveal that cancer of the lip, cancer of the tongue, and cancer of the mouth show a much more favorable outcome than cancer of the esophagus or cancer of the stomach. One does not need to argue that the greater accessibility of these parts to visual inspection is a major factor in this improvement in statistical result.

The use of barium gelatine bougies of varying sizes in the fluoroscopic examination of the esophagus enables the physician to detect very early slight obstructions in swallowing. In this way, without discomfort and without distress to the patient, the physician can ascertain the probable presence or absence of cancer at a much earlier period than he could formerly. Such observations, when critically studied in collaboration with esophagoscopy and cytopathology of the tissue changes presenting, offer a definite advance in the earlier diagnosis and treatment.

The war against cancer of the stomach is being more successfully waged each year. As we study the problem more and more, we realize that here as well the earlier the diagnosis can be made the better will be the result. It follows therefore that the success of our campaign depends to a great extent upon the efficiency of our methods of study. Again may we suggest that these methods of early diagnosis depend largely upon the intelligent use of the x-ray. Patients should be taught the advisability of seeking thorough examinations for the slight but persistent disorders of indigestion commonly called "dyspepsia." The x-ray examination of the stomach causes no discomfort to the patient. There is no reason, therefore, to procrastinate until the symptoms become markedly intrusive. By such delay the seriousness of operative procedure for relief becomes markedly greater. We must remember that the early symptoms of cancer of the stomach are often mild and deceptive, and frequently dismissed, even by the physician, with the general complaint of "indigestion." In these early cases of cancer of the stomach there is found a defect of the gastric outline, manifested either by irregularity or rigidity in the mucous membrane or muscular folds, both departures from normal being presumptive evidence of an early neoplasm. Not only does the x-ray afford a fertile method for the study of the contour and consistency of the lining and wall of the stomach, but also positive means for determining the rate at which the stomach empties. We can then observe an acceleration or retardation of the normal rate, both of which are important in the final conclusion as to the probable condition.

Statistics of the results of the treatment of cancer of the stomach show a marked increase in longevity following operative procedure, so that the older pessimism is now being succeeded by a more optimistic view. If one could insist on an x-ray examination in the average case of so-called indigestion, the brightness of the resultant outlook would certainly become considerably greater. One must, however, bear in mind that merely the use of the x-ray machine is not all that is necessary. Intelligent interpretation of the x-ray shadows, which must be based on fundamental medical knowledge and critical study, is the essential part.

Cancer of the lung must be added to this group of Roentgen diagnostic problems. For some unknown reason cancer of the lung has become much more common in the last few years. A variety of explanations have been offered for this, but so far none have been satisfactory. The diagnosis has usually been made late, and the x-ray has not been of value alone in making an early diagnosis. There is a possibility that the adjuvant of iodized oil for which appreciation must be rendered Doctors Sicard and Forestier, may offer the Roentgenologist assistance by a demonstration of beginning changes in the bronchial lumen, and the patient some hope of relief. This preparation which has been developed within the last few years is easily introduced into the body cavities. And without producing irritation it will give delightfully clear x-ray shadows of the lumen of the cavity. For example, when this oil is introduced into the bronchial tree it causes practically no irritation, and yet will cause shadows which outline that portion of the bronchial tree exactly. In the disease known as bronchiectasis, where there is a very definite enlargement and infection of the bronchi, the physical findings of a tuberculosis and chronic bronchitis are often very difficult to differentiate. However, if the iodized oil is introduced, the size and saculations of the bronchioles are made out with extraordinary accuracy. Many cases of bronchiectasis are in this way diagnosed and treated by methods which are appropriate. Further, this iodized oil is of great value for the injection of small sinuses which, when filled with it, are clearly outlined on the x-ray plate. This same iodized oil may be diluted about 50 per cent. with olive oil and injected into the nasal sinuses such as the antrum, frontal sinuses, etc. A study of the x-ray plates made after injection offers evidences of lack of filling due either to inflammatory diseases or, frequently, to tumors. Comparison with biopsy or surgical specimens may afford us further advance in

the correlation of cyto-pathology and physiology with clinical signs.

Another striking use of the iodized oil is the injection of such bland media into the uterine cavity to demonstrate its outline or the possible inclusion of tumors and to display the size of the lumen and the patency of the Fallopian tubes.

In a discussion of the function of Roentgenology in the study of neoplasms one must not overlook the advances which have been made in the field of neurology. Many brain tumors are very frequently without localizing symptoms. One can frequently feel quite sure of the presence of a brain tumor without being positive as to upon which side it is located, and what particular nerve tracts are involved. In conditions of the brain where there has been a disturbance of the circulation in the ventricles and in the lymphatic system, the x-ray is often of the greatest help. Inasmuch as many brain tumors are attended with disturbance of the collection of fluid in the ventricles, and its evacuation, there follows that many brain tumors could be delineated by the demonstration of this disturbance in a graphic method using the x-rays. The way in which this is effected, in general, is that the ventricles of the brain are tapped under very stringent aseptic precautions and the ventricular fluid is replaced by air. Films are made in different positions so as to show the air-filled ventricles in different angles. These studies of the brain oftentimes show the dilated or distorted ventricles by means of this change in density due to the injected air. Tumors, therefore, which encroach upon the ventricles to produce pressure or distortion are demonstrated. This procedure of ventriculography is one which is not used unless the symptoms are urgent. When, however, an experienced neurologist is confronted with the symptoms of a brain tumor the location of which is not certain, one feels that there is ample justification for an injection of air, which will usually be absorbed in a few days without great risk. It is a procedure which is not, of course, to be undertaken by any one who is not thoroughly familiar with all the various minutiae of the new technique. This must entail careful preliminary laboratory investigation, as has been done by Dandy, Cushing, and others.

The injection of air by way of the spinal column is also one of the newer procedures which is adding much to the study of many of our obscure brain cases. This means, like the one just referred to, is not one to be undertaken except by a thoroughly experienced investigator of the conditions and who has exhausted all the simpler methods of diagnosis. In this the cerebrospinal fluid is replaced by air, the amount of spinal fluid withdrawn being balanced very carefully by the amount of air which is being introduced so that a nearly constant pressure is maintained. X-ray plates are then made with the patient in different positions so as to study the places where the air collects or is blocked. The injection of air directly into the ventricles is spoken of as ventriculography. The injection of air into the spinal column is spoken of as encephalography, and is frequently resorted to now in the study of epilepsy, and for the demonstration of spaces resulting in the brain from previous injury.

We would like to refer briefly to the examinations of the urinary tract. When one compares the difficulties of examinations of a generation or of two generations ago with what is being done at the present time, he feels that there has indeed been great progress made. Careful clinical study, cystoscopic examination, laboratory examination of the excretions of the urinary tract, together with x-ray plates of the involved organs, either with or without the injection of an opaque solution into these viscera, detecting distortions or areas of calcification, have increased the reliability of diagnosis of tumors and dysfunction of the urinary tract manyfold. The skiagrams in such studies offer most conclusive information.

Notable among recent advances in medical science is the linkage of Roentgenology with physiology, pharmacology and biochemistry in the work of Graham and his associates, first published in 1923, on the function of the liver and biliary passages, and their Roentgengraphic demonstrations. The study and development of the utilization of halogen compounds of phenolphthalein as a test of liver and gall-bladder functions has a definite remarkable importance in the entire field of medicine to-day. With this adjunct—cholecystography—the physician is able to visualize and evaluate the function of another of the important viscera in the problem of human illnesses. The collaboration of the chemist in the production of an isomer of the salt of lessened toxicity and greater value as an index of function is most notable. Related work is being carried on in the study of the effects of various drugs on the movements of the intestinal tract in the laboratory animal, a procedure which heretofore necessitated surgical technique and often loss of the animal, together with considerable outlay in apparatus. With the fluoroscope and serial skiagrams the animal may be studied time and again under many variants in conditions. Such study under adequate experimental control will offer the most opportunity for further progress in diagnosis and intelligent therapy.

Treatment of disease by means of x-radiation is entering upon a period in which, with the collaboration of the biophysicist, we may be able to offer relief, if not cure, to the patient. The translation of amounts

of radiation energy into terms of quantity usable on all types of generators has been a serious problem. The biological dose has been in general the only "measuring stick," and there a human error in interpretation has vitiated much work. The development of a biophysical quantity will afford some further knowledge of the process which has taken place in irradiated tissue. With the establishment in the last year by the International Congress of a physical unit of the *r*, or Roentgen unit, there is in sight a standardization of x-radiation dosage on a uniform scale. This is of value both in diagnostic exposures and in therapy. The collaboration of the Bureau of Standards in maintaining a standard scale is a further step forward toward a universal standard of measurements.

With the continuance of the interest and the close cooperation and enthusiasm of the physicist, the biologist, and the Roentgenologist in the study of the effect of x-radiation on tissue, and its relation especially to the combat of the neoplasm, we may anticipate much of value to medicine and *"les malades,"* and of interest to science as a whole.

OBITUARY

MATTHEW FONTAINE MAURY[1]

FINE Virginia blood flowed in the veins of Matthew Fontaine Maury. His grandfather, James Maury, was an Episcopal clergyman who kept a small school in Albemarle County, which numbered among its pupils Jefferson, Madison and Monroe, three distinguished presidents of the United States who had much to do with starting out the University of Virginia in the way that it should go. Born in 1806, the fourth son in a large family, he soon imbibed among pioneer surroundings courage and self-reliance, a love of honor and independence of thought, and, best of all, a burning desire to know and to achieve. In a curious manner he became interested as a boy in the study of mathematics, which was to play such an important part in his future life. He relates the incident in these words, "My first ambition to become a mathematician was excited by an old cobbler, Neal by name, who lived not far from my father's house, and who used to send the shoes home to his customers with the soles all scratched over with little x's and y's."

At the age of nineteen, he became a midshipman in the United States Navy, and his first cruise was on the *Brandywine,* which carried back to France the great Lafayette after his memorable visit to the United States. Maury started his career with a determination to overcome all obstacles, no matter how disagreeable the task. The success he had in life was attained not so much by a great brilliancy of mind but rather as the result of sheer hard work. In his own words, he says:

> When I became old enough to reflect, it was the aim at which all my energies were directed to make myself a useful man. I soon found that occupation, for some useful end or other, was the true secret of happiness. . . . When I went on board ship, I set out to make everything bend to my profession. I was required to study Spanish; and that nothing might be lost, I got a Spanish work in navigation and studied that. . . . I used to draw problems in spherical trigonometry with chalk on the shot, and put them in the racks where I could see them as I walked the deck.

So well did he school himself by these methods that when his book on navigation was published in 1836, the first nautical work ever to come from the pen of an American naval officer, it soon became the standard treatise on the subject.

The navy of one hundred years ago was unfortunately in a condition of dry rot, and some one with courage was needed to come forward and point out the remedies. Maury accepted the challenge and wrote a series of articles dealing with reforms. At first he wrote under a pseudonym, but he soon won the sympathy and approval of the officers of the Navy. So excellent were the reforms suggested that when the author became known, the President of the United States had all but decided to allow him to put his theories into practice by making him the Secretary of the Navy, in spite of the fact that his rank was but that of lieutenant.

So famous had his writings made him by this time that he was appointed in 1842 as head of the Depot of Charts and Instruments. Here was the opportunity for Maury to show his worth. When he took charge, the office was a very small one, but it grew quickly in size and importance until its name was changed to that of the United States Naval Observatory. The superintendent, although a naval officer, knew little of the science of astronomy. With characteristic determination he immediately started out to teach himself. To those of us who are familiar with telescopes vastly greater than he had ever dreamed of, it is interesting to read the enthusiastic manner with which he describes the passage of a star through the field of view of a transit instrument. His enthusiasm and his love of work affected his subordinates to such a degree that soon the Naval Observatory took rank with the two national observatories of

[1] Address given on the occasion of the unveiling of his bust at the Hall of Fame of New York University, May 14, 1931.

Europe, founded nearly two centuries earlier, Paris and Greenwich.

In addition to his ability to do hard work, Maury was fortunately gifted with a lively imagination. He, therefore, planned for the Naval Observatory a very ambitious scheme, that of making a catalogue of all the stars down to the tenth magnitude that could be seen from the latitude of Washington. This comprehensive project was too great a task for any one observatory to handle and so perforce it was necessary to await the time when it could be taken up by many observatories working in cooperation. Such a catalogue was actually completed some fifty years later under the auspices of the Astronomische Gesellschaft, or German Astronomical Society. Maury was superintendent of the Naval Observatory for nearly twenty years, resigning his post at the outbreak of the Civil War.

His name is best known to us now from the pilot charts issued each month at Washington, at the top of which are found these words, "Founded upon the researches made and the data collected by Lieutenant M. F. Maury, U. S. Navy." In the year 1831 he was appointed sailing master of the *Falmouth*. Before proceeding to Rio he had sought from all the books available information on the winds, weather and currents likely to be found on the cruise. Search as he would there was no published information. Maury had a brilliant thought, beautifully described by one of my colleagues at the University, which was that, "the sea, if investigated, would be found to have its laws as constant, as uniform, as invariable as those of the land. Nature was to Maury one and indivisible. She was as sovereign over the three fourths of the world which was fluid as over the one fourth which was solid. The waves, the winds, the storms, the currents, the depths and the temperatures of the sea were believed by Maury to constitute a system, a complex of cause and effect, constant in its regularity, perfect in its orderliness, and so mathematically interrelated that the mind of man could by patient investigation understand its phenomena and ever forecast its processes."

Maury determined to make the sea give up her secrets by observing her vagaries. His own observations on his trip to Rio availed but little. Many observers spread over many seas and over long intervals of time were needed. But how to secure them, and how wait patiently while the observations were being accumulated? Help came from an unexpected quarter. In the observatory offices where Maury went in 1842 there was a collection of what was regarded as so much rubbish, old log books of past generations of naval vessels, apparently fit only for a bonfire. It took five years of hard work to bring order out of chaos, and it was not until 1847 that he published his first "Wind and Current Chart." But what good were his precepts? Were they only the vapid musings of a fossilized old astronomer, or would the time of passage of a ship from one port to another actually be shortened? That was the real test. And what a triumph was in store! The average voyage by a sailing vessel from New York to Rio had been 55 days. By following Maury's directions, a barque early in 1848 on its trip south made the voyage in 35 days and returned in 40 days. When ship captains found that they could have a copy of his sailing directions by agreeing to make observations and to send them in to Washington, Maury was able to write that by 1851 he had more than one thousand ships in all the oceans observing for him.

Gold was discovered in California in 1849. In rushing supplies from New York to San Francisco, 15,000 miles distant, time was undoubtedly money. The average voyage was 180 days. The clipper ships of those days had exciting races. As Maury wrote, "Some of the most glorious trials of speed and prowess that the world ever witnessed, among ships that walk the waters, have taken place over it. Here the modern clipper ship—the noblest work that has ever come from the hands of man—has been sent, guided by the lights of science, to contend with the elements, to outstrip steam and astonish the world." Many ships made the voyage in 110 days, the record for a clipper ship is 90 days.

It has been estimated that Maury's charts made an annual saving to the commerce of the United States of those days of more than two million dollars, while British commerce saved each year the sum of ten million dollars.

Maury's fame was still in the ascendancy. In 1853 an international congress was held in Brussels, the first League of Nations. At its close Maury's charts were adopted and plans were made for further cooperation by nineteen twentieths of the shipping of the world. Transatlantic sea lanes were adopted which have remained almost unchanged to the present. One year after the conference had met he published the first depth map of the North Atlantic and he later assisted in laying the first Atlantic cable. In 1855 he published his "Physical Geography of the Sea" and inaugurated a new science.

He strongly urged that systematic observations of weather conditions should be made all over the United States and the results be telegraphed to a central bureau. Political jealousies retarded this movement and it was not until many years later that the U. S. Weather Bureau was organized. Maury has been frequently referred to as the father of the U. S. Naval Academy.

Scientists when great are usually modest. Sir Isaac Newton was buried in Westminster Abbey with royal honors. Of himself he has said, "I have been but as a child playing on the seashore; now finding some pebble rather more polished and now some shell more agreeably variegated than another, while the immense ocean of truth extended itself unexplained before me." And so it was with Maury. He did not lay claims to great discoveries. "I only bring together," he wrote, "the observations that others have made, and then leave it to the observations themselves to discover their own meaning in their own way."

His life should be an inspiration to every youth of to-day, showing as it does so clearly that hard work, with enthusiasm and imagination, will overcome nearly all difficulties.

S. A. MITCHELL
LEANDER MCCORMICK OBSERVATORY,
UNIVERSITY OF VIRGINIA

MEMORIALS

THE *Journal* of the American Medical Association states that ceremonies in memory of Fernand Widal were recently held in Paris. Professor Pasteur Valléry-Radot (grandson of Pasteur), who was a pupil of Fernand Widal and who is now an associate professor at the Medical School, delivered an address on the work of his former teacher. He described his methods of work and experimentation and recalled the discoveries for which science is indebted to him.

Nature states that at a special meeting of the council of the Ray Society on April 30, the following resolution was adopted: "The Council of the Ray Society desire to place on record the profound grief felt by them on hearing of the death of their president, Professor W. C. M'Intosh, F.R.S., on April 1 last. Professor M'Intosh had belonged to the society since 1863 and had been president since 1913. He had not only shown his practical interest in its success by his exceptionally long period of membership, but he had given the most devoted service to the society by his frequent journeys from St. Andrews to London, in order to attend the meetings of the council, at which he nearly always presided. The council direct that this record of their appreciation of the value of their late president's work be sent to Dr. R. T. Gunther, his nearest surviving relative, with the expression of their sincerest sympathy."

RECENT DEATHS

DR. SOLON IRVING BAILEY, professor emeritus of astronomy at Harvard University, from 1892 to 1919 in charge of the Arequipa branch of Harvard College Observatory, died on June 5, in his seventy-seventh year.

DR. FRANK WIGGLESWORTH CLARKE, chief chemist of the U. S. Geological Survey, *retired*, well known for his work on the constants, atomic weights, geochemistry and other subjects, died at his home in Chevy Chase, Maryland, on May 23, in his eighty-fifth year.

DR. EDWARD HART, professor emeritus of chemistry at Lafayette College, died on June 6, at the age of seventy-six years.

DR. SAMUEL W. BEYER, dean of the industrial science division of Iowa State College, was fatally hurt when his automobile was struck by a passenger train on June 2. Dr. Beyer, who was sixty-six years of age, was known for his work in economic geology.

THE death is announced of Dr. Carroll Gideon Bull, professor of immunology in the School of Hygiene and Public Health of the Johns Hopkins University.

DR. BENSON AMBROSE COHOE, professor of therapeutics at the University of Pittsburgh Medical School since 1920, died on May 27, at the age of fifty-six years.

WILLIAM DOBINSON HALLIBURTON, emeritus professor of physiology at King's College, London, died on May 21, at the age of seventy-one years.

PROFESSOR JOSEPH EDWARDS, principal and professor of mathematics and physics at Queen's College, London, died on May 30, in his seventy-eighth year.

MR. ST. GEORGE LITTLEDALE, known for his explorations in central Asia, died on April 16, at the age of seventy-nine years.

SCIENTIFIC EVENTS

RECONSTRUCTION OF THE ROYAL INSTITUTION

THE *British Medical Journal* states that the rebuilding of a considerable part of the Royal Institution became imperative some two years ago, after a series of explosions in Albemarle Street, which compelled the attention of the managers to the dangerous condition of the lecture theater. This historic room, the scene of the Friday evening discourses and experiments of Davy, of Faraday, and of a long line of distinguished scientific men over a period of one hundred and thirty years, had remained almost unchanged since it was completed under the supervision of the founder of the institution, Count Rumford, in 1802.

It was built entirely of timber, and by modern standards was very ill provided with exits. A survey made two years ago showed the fire risks to be so grave that they could no longer be ignored. Plans were prepared, and a scheme of reconstruction was undertaken. This has now been completed, and a house-warming party was held on the evening of May 6. The principal consideration in the rebuilding has been to satisfy modern standards of security by means of fireproof construction and by the provision of suitable exits; but the perfection of the design of the lecture theater for the scientific purpose for which it was built has been recognized the world over, and succeeding generations of members have held their meeting room in affectionate regard, so that it has been a particular care to effect the restoration with as little modification of its qualities and appearance as possible. Advantage has naturally been taken of the opportunity to bring the equipment up to date, and the theater has been provided with a cinematograph projector, an epidiascope, a great variety of services to the lecture table for experimental purposes, and a number of other refinements for the assistance of the lecturer and the convenience of his audience. The rebuilding of the lecture theater has involved the replanning and reconstruction of a large adjacent part of the building. On the ground floor the arrangements have been largely determined by the requirements for exit to the street from the theater above. A new entrance hall has been constructed, some of the rooms have been replanned, and a large new chemical laboratory has been built. During the evening Sir William Bragg, Fullerian professor of chemistry and director of the laboratory, demonstrated to the guests some of the classical experiments of the Royal Institution.

THE INTERNATIONAL CONGRESS FOR STUDIES REGARDING POPULATION

ORGANIZED by the Italian committee for the study of population problems an *International Congress for Studies Regarding Population* will be held in Rome from September 7 to 10.

His Excellency the Head of the Government, Benito Mussolini, has accepted the honorary chairmanship of the congress, while the effective chairmanship is entrusted to Professor Corrado Gini, president of the Italian committee.

The organization of the congress will include: (*a*) An honorary committee; (*b*) An International Committee of Patronage, composed of presidents and representatives of National Scientific Organizations for the study of population problems and other personalities who will be entrusted with the propaganda for the congress in their own countries and with the relations between the organizing committee and those engaged in these studies in the respective associations; (*c*) An Organizing Committee, composed of Italian members who will be entrusted with the organization of the congress and will be responsible for the acceptance of communications.

The program of the congress is purely scientific, so that any political, moral or religious propaganda whatever is forbidden, even if questions concerning the problems of population are involved.

For the distribution of the scientific papers the congress will consist of the following sections: Biology and Eugenics, Anthropology and Geography, Hygiene and Medicine, Demography, Economy, Sociology, History, Methodology.

Each meeting will be presided over in turn by specialists belonging to different nationalities. The congress will be open to the public. All taking part in the congress will be entitled to send communications of which the final text should reach the organizing committee before July 1.

Some subjects of special importance, chosen by the organizing committee, will be the object of reports by persons previously nominated and will be submitted to discussion by the sections.

The fee entitling to take part in the congress and to receive a copy of the proceedings is fifty lire for all those invited, whether individually, or through national scientific committees or associations, and one hundred lire for others taking part in the congress.

All those who take an interest in the congress and would like to receive the detailed program are invited to apply to the "Comitato Italiano per lo Studio dei Problemi della Popolazione."—10, Via delle Terme di Diocleziano, Roma (Italia).

RANGE RESEARCH CONFERENCE AT EPHRAIM, UTAH

THE Ecological Society of America is sponsoring a meeting for the purpose of discussing range research with particular attention to methods. The program is being planned to give opportunity for field discussions and demonstrations as well as for more formal discussions. The committee in charge of arrangements consists of C. L. Forsling, *chairman;* H. C. Hanson, Walter P. Taylor and W. G. McGinnies, *secretary*.

The tentative program includes a discussion of the following topics:

1. Methods of studying plant populations and their changes.
2. Methods of studying forage production and yield, including clipping, height growth, volume determination or other methods; clip quadrats,

their location, treatment and charting, systems of clipping, weighing, value and limitations.

3. Methods of studying plant development for seasonal use and other purposes, autecology-phenology and life histories; value and methods; period studies, panel exclosures, and other methods including procedure, measurements, equipment, value and limitations.
4. Utilization and palatability, methods of measuring and computing for different kinds of vegetation.
5. Methods for controlling the grazing factor, including isolation transects, permanent exclosures and inclosures, intermediate control inclosures and exclosures, and other fenced plots.
6. Instrumentation, essential facts to measure, instruments and analysis correlation, and presentation of data.
7. Methods of studying the influence of grazing on saw timber types.
8. Methods of studying inter-relation between grazing and erosion.
9. Methods of studying animal life, including livestock, rodents, big game, upland game birds and other birds and animals.
10. Terminology—suggestions regarding standardization—(a) standard terms, (b) open terms.
11. Plant nomenclature—(a) scientific names, (b) common names.
12. Compilation and analysis of range research data with special attention given to the use of statistical methods.

The committee hopes to prepare a detailed account covering the various topics for discussion at the meeting. In order to do this it is necessary to have available outlines of the various methods in use by different investigators. The committee would be glad to receive any suggestions as to points to be discussed and would especially like to have each investigator submit outlines or other descriptions of methods used in range research.

It would greatly facilitate matters if every one would send the secretary his own name and address and the names and addresses of others who might be interested in order that subsequent announcements may be properly sent.

THE AMERICAN INSTITUTE OF PHYSICS

PLANS for formation of a consolidated scientific organization to be known as the American Institute of Physics have been made public by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

Both science and the public are to be served. The institution will bring together several scientific organizations now separate but having common interests. It will also knit together a great group of men in industrial laboratories and manufacturing plants who, as physicists, play a most fundamental rôle in modern industry, but who have not heretofore constituted a well-recognized unit. Also in schools and colleges, local or student branches of the institute may be found. For the public there will be a press department to explain some of the fascinating laboratory happenings which often remain masked behind unfamiliar scientific words. This will include cooperation with the press and contacts with local groups interested in physics.

The plans were started jointly by the American Physical Society, the Optical Society of America and the Acoustical Society of America. The Society of Rhedology has also joined in the movement to establish the institute and several other national as well as some local organizations have expressed interest in joining or becoming affiliated with it.

Dr. Compton is chairman of the governing board of the institute, which has been set up jointly by the cooperative societies to work out the organization problems. The secretary of the board is Dr. George B. Pegram, head of the department of physics and formerly dean of engineering in Columbia University. Other members include directors and leaders in some of the largest industrial research laboratories as well as university men.

The productivity of American research physicists has increased so rapidly that the present means of publication of their results have been quite overstrained. Hence one immediate objective of the cooperating societies is to achieve through the new institute unified and enlarged publications for research results and other information in physics, including abstracts of all published work in physics over the world. In this publication to cover the field of physics it is expected to attain a high standard of completeness and promptness. The Chemical Foundation, Inc., of New York, has offered to undertake the handling of the business end of the publication.

HONORARY DEGREES CONFERRED BY COLUMBIA UNIVERSITY

THE recipients of the honorary degrees of doctor of science at the recent commencement of Columbia University with the formulae used by President Nicholas Murray Butler in conferring the degrees were:

JAY DOWNER, chief engineer of the Westchester County Park Commission—Native of Iowa; graduated at Princeton University with the class of 1905; for some twenty years associated as planner and leader with the development of the neighboring county of Westchester; a singularly high type of public servant, endowed with that vision and courage which multiply

the force of his engineering ability and which so well equip him with the skill to unite the useful and the beautiful.

LUTHER PFAHLER EISENHART, dean of the faculty of Princeton University—Native of Pennsylvania; studying first at Pennsylvania College and then at the Johns Hopkins University; preparing himself by intensive work in mathematics for the scholarly labors which he now pursues; trusted and competent adviser of undergraduate youth; a powerful force in the work of the Princeton University of to-day, that sister university and honored neighbor which, like our own King's College, traces its origin to an original charter granted by authority of George II.

CHARLES JUDSON HERRICK, professor of neurology in the University of Chicago—Native of Minnesota; trained at the University of Cincinnati, at Denison University and at Columbia; eagerly pursuing advanced study and research in his chosen field with marked success; recipient of many honors from his fellowmen of science; fertile and suggestive writer on biological and neurological topics; for well-nigh a quarter century a distinguished member of the University of Chicago.

ARTHUR DEHON LITTLE, chemical engineer—Native of Massachusetts; a captain in the organization and direction of research in the science of chemistry in all its manifold revelations; covering in his field of interest and influence almost every aspect of chemical engineering practice; fertile in invention, practical in application and a genuine leader in the preservation and advancement of that organized body of knowledge which we know as science; one who, as even Sir Humphry Davy would admit, pursues science with true dignity.

SCIENTIFIC NOTES AND NEWS

THE annual list of honors conferred on the occasion of King George's birthday included the Order of Merit on Sir William Henry Bragg, Fullerian professor of chemistry and director of the Royal Institution.

LORD RUTHERFORD has been elected president for the year 1931–32 of the British Institute of Physics.

DR. JAMES HENRY BREASTED, director of the Oriental Institute of the University of Chicago, has been elected a foreign member of the Bavarian Academy of Sciences.

ON the occasion of the fifty-ninth annual commencement of Stevens Institute of Technology at Hoboken, New Jersey, the doctorate of science was conferred on Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, who delivered the commencement address.

AT the recent commencement of Wake Forest College, the degree of D.Sc. was conferred on Dr. Hubert Royster, lecturer in Duke University, formerly dean of the Raleigh division of the Medical School of the University of North Carolina.

DR. PHILIP FOX, director of the Adler Planetarium, Chicago, received an honorary doctorate from the Kansas State Agricultural College on the occasion of its sixty-eighth annual commencement in May 28.

THE University of Göttingen has renewed after fifty years the doctorate degree of Dr. Stephen Moulton Babcock, professor of agricultural chemistry at the University of Wisconsin. In transmitting the renewed diploma through Professor Karl Freudenberg, who is the Carl Schurz professor of chemistry at the university, Dr. Wilhelm Seedorf, dean of the University of Göttingen, called special attention to the fact that the work of Dr. Babcock has been of great significance to German agricultural scientists, and that his work is held in very high esteem. The diploma, presented to Dr. Babcock in the presence of a group of his immediate associates and friends, reads as follows: "Under the jurisdiction of his excellency, the rector, Johannes Behm, the mathematical and natural science faculty of the George August-University renews through its dean, Professor Dr. Wilhelm Seedorf, the diploma of doctor of philosophy degree, dated February 28, 1879, granted to Mr. Stephen Moulton Babcock, the extraordinarily distinguished investigator in the chemistry and bacteriology of milk and therefore of agriculture in general, and extends its heartiest greetings and wishes for a continued happy old age."

AT the commencement exercises of Tuskegee Institute, at Tuskegee, Alabama, a bronze bas-relief was unveiled of Dr. George W. Carver, director of the Agricultural Experiment Station at Tuskegee and consulting chemist. Dr. Carver has been working in botany and agricultural chemistry at Tuskegee for thirty-five years.

THE council of the British Institution of Electrical Engineers has made, as reported in *Nature*, the following award of premiums for papers read during the session 1930–31, or accepted for publication: the institution premium to Commendatore G. Bianchi, Ayrton premium to R. Grierson, John Hopkinson premium to J. W. Rissik and H. Rissik, Kelvin premium to B. L. Goodlet, F. S. Edwards and F. R. Perry, Paris premium to P. J. Ryle, and extra premiums to W. E. M. Ayres; R. M. Charley; H. S. Carnegie; D. B. Hoseason; Dr. J. J. Rudra and Professor Miles Walker; Professor W. Cramp and A. P.

Jarvis; P. J. Higgs; J. C. Prescott and E. W. Connon; G. G. Smail, R. J. Brooksbank, and Professor W. M. Thornton; Professor S. P. Smith; and Professor E. Wilson. In the Wireless Section, the Duddell premium has been awarded to T. Walmsley and extra premiums to C. E. Horton and C. E. Rickard. In the Meter and Instrument Section, the Silvanus Thompson premium has been awarded to Professor W. M. Thornton, M. Waters and W. G. Thompson, and an extra premium to E. W. Hill and G. F. Shotter.

The daily press reports that the appointments of twenty members of the faculty of the University of Kansas have not been renewed. Among these is Dr. A. A. Schaeffer, professor of zoology.

The title of emeritus professor has been conferred on Sir Charles J. Martin, professor of experimental pathology, and Dr. Arthur Hardin, professor of biochemistry, of the University of London.

Dr. Frank Lusk Babbott, Jr., has been appointed president of Long Island College of Medicine, Brooklyn, to succeed Dr. James C. Egbert. The newly appointed president will assume his full time duties on July 1. Dr. Babbott, who has been associated with the department of pediatrics at the medical college for several years, has been assistant professor of pediatrics and assistant dean since 1927. He received his M.D. degree from Columbia University College of Physicians and Surgeons in 1918.

Dr. Carroll William Dodge, assistant professor of botany and curator of the Farlow Library at Harvard University, has been appointed professor in the Shaw School of Botany at Washington University.

Dr. George B. Cressey, formerly of Shanghai College, China, and at present at Clark University, has been appointed head of the department of geology, mineralogy and geography at Syracuse University. This new department represents a union of the work in geology, formerly under Dr. Thomas C. Hopkins, who retires this year, and mineralogy under Dr. Charles H. Richardson, who continues as senior professor.

Dr. Patrick H. Yancey, instructor in biology in St. Louis University, has been appointed professor of biology and director of the department at Spring Hill College, Mobile, Alabama.

Dr. Edward F. McCarthy has been appointed head of the department of silviculture of the New York State College of Forestry at Syracuse. He was formerly a member of the college faculty and succeeds the late John W. Stephen.

Mr. A. E. Naish, physician to the Sheffield Royal Hospital and lecturer in medicine in the University of Sheffield, has accepted the invitation of the council of the University of Edinburgh to become professor of medicine.

Dr. Walter R. Kirner has resigned his position as assistant professor of organic chemistry at the Rice Institute, Houston, Texas, to accept a position as organic chemist on the staff of the Coal Research Laboratory of the Carnegie Institute of Technology. His new duties at Pittsburgh will include the organization of a laboratory for quantitative micro-organic analysis.

Mr. James F. Walsh, formerly vice-president and technical director of the Celluloid Corporation, has joined the consulting staff of Arthur D. Little, Inc., of Cambridge, Massachusetts.

The American Standards Association has announced the appointment of H. M. Lawrence, mining engineer, and S. W. Benham, as assistant engineer, on the staff of the association. Mr. Lawrence will have supervision of all the mining, chemical and ferrous and non-ferrous metallurgical projects being developed under the procedure of the association. Mr. Benham will assist in the supervision of civil engineering and transportation projects. Mr. Lawrence has been mining engineer with the International Agricultural Corporation. From 1924 to 1930 he was connected with the U. S. Bureau of Mines as metallurgist. Mr. Benham has been connected with the Portland Cement Association and with the Johns-Manville Corporation.

We learn from the *Journal* of the American Medical Association that Dr. Clarence L. Scamman, Boston, has resigned as deputy commissioner of public health of Massachusetts and director of the division of communicable diseases, to become director of the division of public health of the Commonwealth Fund of New York, succeeding Dr. William J. French, resigned. He will have charge of the development of rural health service in various states. Dr. Scamman was given a farewell dinner, May 1, at the Harvard Club of Boston by friends and co-workers and presented with a traveling bag. Dr. George H. Bigelow, commissioner of public health, presided. Dr. Gaylord W. Anderson will succeed Dr. Scamman, and Dr. Nels A. Nelson will succeed him as assistant director of the division of communicable diseases.

Professor C. H. Desch has been appointed superintendent of the metallurgy department of the British National Physical Laboratory, in succession to Dr. Rosenhain. Professor Desch, who is a fellow of the Royal Society and of the Institute of Chemistry, is at present professor of metallurgy and dean of the faculty at the University of Sheffield. He will

not take up his new appointment until February, 1932, as he had previously accepted an invitation from Cornell University to give a course of lectures there during the winter session of 1931–32.

DEAN HUGH P. BAKER, of the New York State College of Forestry at Syracuse University, has been appointed a delegate to represent the college at the International Conference on Forestry to be held in Paris, from July 1 to 4.

PROFESSOR H. S. JENNINGS, of the Johns Hopkins University, is to spend the academic year 1931–1932 as visiting professor at the Keio University, Tokyo, Japan. His address until June 30, 1932, will be Medical School, Keio University, Tokyo, Japan.

DR. H. W. STUNKARD, professor of biology at New York University, has been granted sabbatical leave from the university for the academic year 1931–32. For this period he has been awarded a fellowship of the Guggenheim Foundation to continue his researches on the biology and life history of certain parasitic flatworms in European laboratories. He is sailing the latter part of June and will spend the major portion of the time with Professor F. Fülleborn, in the Institut für Schiffs- und Tropenkrankheiten, Hamburg.

DR. JOHN S. KARLING, professor of botany at Columbia University and physiologist of the Tropical Plant Research Foundation, Washington, D. C., sailed on May 22 for British Guiana to continue his research work in the tropics. This is the eighth expedition he has undertaken to tropical America as director of the Chicle Research Project. At Tower Hill in the Orange Walk District an experiment station and plantation of more than fifty thousand acres have been established in efforts to evolve a new system of tapping the sapodilla tree which will make it more suitable for plantation culture.

DR. NEVIL V. SEDGWICK, of Lincoln College, Oxford, spoke at Iowa State College, June 3, on "Divalent Carbon."

PROFESSOR W. M. DAVIS has lately given five lectures on "The Coral Reef Problem Treated in Illustration of Scientific Method" to students of the department of geology of Stanford University, where he is also conducting an advanced course in physiography during the spring term.

THE installation of Dr. Charles Chester McCracken, who succeeded Dr. George Alan Works as president of the Connecticut Agricultural College at Storrs a year ago, took place on June 6. The exercises also marked the fiftieth anniversary of the college. Governor Wilbur L. Cross presided at the inauguration and inducted Dr. McCracken into office. Addresses were made by Dr. W. O. Thompson, president-emeritus of the Ohio State University, and by Dr. McCracken. The baccalaureate sermon on Sunday was delivered by Dr. McCracken, who spoke on "The Potter and His Clay." The commencement address on June 8 was given by Professor Edmund W. Sinnott, of Columbia University, who was formerly professor of botany and genetics at Storrs.

APPLICATIONS for the position of associate biochemist (fungicide investigations) must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than July 10, 1931. The examination is to fill vacancies in the departmental and field services. The entrance salaries range from $3,200 to $3,800 a year. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience and writings. Applicants must have been graduated with a bachelor's degree from a college or university of recognized standing, with major work in chemistry, and, in addition, must have had at least three full years of graduate study or productive research experience in physical chemistry, including plant colloids and physical properties of solutions. Applicants also must have demonstrated ability in devising laboratory methods and equipment.

THE Royal Photographic Society of Great Britain is holding its seventy-sixth annual exhibition in London in September and October of this year. This is the most representative exhibition of photographic work in the world, and the section sent by American scientific men heretofore has demonstrated the place held by this country in applied photography. It is hoped that the scientific section will be thoroughly well represented in 1931, and in order to enable this to be done with as little difficulty as possible arrangements have again been made to collect and forward American work intended for the scientific section. This work should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy, radiography, biology, etc. Photographs should be mounted but not framed. They should be sent at once to A. J. Newton, Eastman Kodak Company, Rochester, New York.

AT a three-day field conference of professional geologists at the Pennsylvania State College, it was decided to effect an organization to promote pure and applied geological research in the state, and to encourage future field studies by the group. Professor C. A. Bonine, head of the department of geology at the college, will lead the second field conference which will be held in the Lehigh Valley with Lafayette College and Lehigh University acting as the hosts.

DISCUSSION

THE ACCURACY OF WIRELESS TIME SIGNALS

THE purpose of this communication is to give a brief account of the accuracy to be expected of the time signals offered by American broadcasting stations. No attempt will be made here to discuss the relative accuracy of the time signals broadcast by various observatories scattered over the earth, nor will the advantages and disadvantages of the differing methods used by these observatories in relaying signals be considered. Persons primarily interested in these "official" time signals will find much valuable information concerning them in the "Handbook" for 1931 of the British Astronomical Association.

The data on which the following discussion is based were gathered during the past two and a half years and include more than 500 comparisons of signals from fifteen broadcasting stations. The comparisons were made using a stop-watch which reads to fifths of seconds and a watch of fairly uniform rate. The latter was compared regularly with the time signals from the U. S. Naval Observatory at Washington, D. C., a short-wave receiving set being used to pick up the signals.

There are three common ways of announcing the time to the listening public. One is to have the announcer state that "It is now *exactly* one fifty-nine and one half, Eastern Standard Time by the celebrated Blank watch." Another method is to use a bell or a chime, preceded by an announcement such as: "When you hear the musical note, it will be exactly two minutes after two P. M., Central Standard Time." The third method is to use a superimposed tone beat every hour on the hour and, in some cases, also on the half hour. Ordinarily there is no warning that this beat is coming.

The first of these methods has been found to be the least precise in practice. Even though the announcer may place considerable emphasis on the word "exactly," such announcements are often fifteen seconds in error, and sometimes are wrong by a minute or more. A good seventeen-jewel watch set once a week by some accurate wireless time signal will prove more reliable as an authority on time than the average signal of this sort.

Signals from broadcasting stations using the second method are usually quite accurate. The name of the company sponsoring the signals has been found to be a good indication of the accuracy to be expected. One company sponsoring signals over a number of stations has provided signals which are almost never more than five seconds in error while the numerical average of their errors has been found to be slightly less than one second. Another company provides signals which are seldom less than ten seconds in error and on the average are in error by about twenty seconds. The use of a gong, bell or musical note for time announcements as inaccurate as these must be considered as misleading, if not actually dishonest. Fortunately this situation is not common in practice and one can generally rely on "gong" signals being less than five seconds in error.

The superimposed tone beats every hour on the hour ordinarily provide the most accurate time signals excepting those originating in an observatory. Some broadcasting stations using this form of signal maintain an accuracy that is really surprising, the error of their signals invariably being less than one second. In general one may reasonably expect the error of superimposed tone beats to be less than three seconds. There are, however, two criticisms to be made of this type of signal. The first has already been mentioned, namely, that the signals come without warning. The second is that occasionally a station will temporarily discontinue this service. This criticism does not apply to most stations offering this type of signal, but some stations are notoriously undependable in this respect.

These three types of signals offer a great service to the American public. There can be little doubt that their accuracy is sufficient for most purposes. Only jewelers, astronomers and perhaps a few others have need for greater accuracy and these can easily arrange to receive the time signals of some observatory.

CHARLES H. SMILEY
BROWN UNIVERSITY

RECENT CLIMATE AND VEGETATION A FACTOR IN THE MOUND-BUILDING CULTURES?

WHETHER one sees much or little in the problem of ethnic identity of the mound-builders, there seems to be no question that the Hopewell culture at least represents a higher level than anything else known in the north-central states.[1] Certainly, too, the finest works and the artifacts associated with them were not being produced at the time of white exploration, whatever the blood kinship of their authors might have been. It also appears to be conceded that the flowering of these better cultures rested upon the basis of a successful maize agriculture. As mapped by Shetrone[2] the western limits of the northern mound culture are essentially those of the present corn belt, but the

[1] H. C. Shetrone, "The Mound-Builders," p. 479, 1930.
[2] *Ibid.*, p. 28.

highest expression, namely, the Hopewell, lies well toward the east in this area.[3]

Without binding oneself to the thesis of Huntington,[4] that climates virtually control civilization patterns, it may be well to note that middle western climate has been until recently much less humid as judged by vegetation than it is to-day. This fact has been developed quite independently of parallel evidence in Europe. It was first established on good floristic grounds by Gleason, whose most recent paper[5] gives an excellent summary. Meanwhile Auer,[6] in Canada, and the present writer and his students, working in Iowa and the Erie Basin,[7] have secured good confirmatory evidence from a microscopic study of recent peats. Additional confirmation is afforded by a recalculation of the results reported by Lewis and Cocke[8] for the Dismal Swamp of Virginia.

Making due allowance for all the difficulties and sources of error involved in reconstructing past climates, it may be safely stated that until a few hundred years ago the characteristic vegetation of the corn belt lay considerably to the eastward, and has since shifted west. Many other details of postglacial climate are still highly debatable, but this at least appears well enough established to merit attention from all who are concerned in interpreting biological phenomena in the United States. The westward swing of such conditions in recent centuries was accompanied by an advance of the humid deciduous forest from south and east. Did this favor cultures which lived largely by war and chase as against those more dependent on tilling the soil (without the aid of steel tools and draft animals)? Did this change become effective before or with the great interior displacement of American tribes caused by white pressure and bartered firearms from New England and Dutch New York?

Any causal explanation which the writer might advance would be mere conjecture. But the fact remains that the cultural climax of the northern maize civilization occurred toward the east of the present corn belt, and at a time when corn-belt conditions were in all likelihood east of their present location.

PAUL B. SEARS

BOTANY DEPARTMENT,
UNIVERSITY OF OKLAHOMA

[3] *Ibid.*, p. 187.

[4] E. Huntington, "Civilization and Climate," 2nd Ed. 1922.

[5] H. A. Gleason, "The Vegetational History of the Middle West," *Ann. Assoc. Am. Geog.*, XII, 39–85, 1922.

[6] V. Auer, "Peat Bogs in Southeastern Canada," *Mem.* 162, Geol. Surv., Can., 1930.

[7] Inv. Manuscript read before Syst. Sec. Bot. Soc. Am., December, 1930.

[8] Lewis and Cocke, "Pollen Analysis of Dismal Swamp Peat," *Jour. Elisha Mitchell Soc.*, 45: 37–58, 1929.

TYNDALL BEAM INTENSITY OF TURBID COLORED SOLUTIONS

MOST of the work on the Tyndall beam intensity of turbid solutions has been carried out with dispersions in colorless media, or in such a way that the absorption due to the dispersion medium could be neglected. P. V. Wells has shown (*Chemical Reviews,* 3: 331) that under these conditions the Tyndall beam intensity is a power function of the depth or the concentration as a first approximation. The writers have used the Pulfrich photometer, manufactured by Zeiss, to investigate the turbidity in a colored raw sugar, in solutions of varying depth and concentration. Under these circumstances a correction must be applied for the absorption due to the coloring matter. It was found experimentally that Wells' equation holds if there be substituted for the Tyndall beam intensity itself, the ratio between it and the percentage transmittancy of the same solution, measured in the same absorption cell and at the same wave-length. For equal concentration at varying depth, or for equal depth at varying concentration, the exponent in the formula is independent of wave-length. The detailed results of this investigation, which is being continued, will be published elsewhere.

LOUIS SATTLER
F. W. ZERBAN

NEW YORK SUGAR TRADE LABORATORY,
NEW YORK, N. Y.

THE CURVATURE OF SPACE

IN an address made at the dinner in honor of Professor Einstein at the California Institute of Technology, Professor Frederick H. Seares made some very interesting remarks about the curvature of space. After explaining how Einstein has shown us that we may with advantage change some of the rules of world building, he makes the rather astounding assertion "that curved space means only a new set of rules which require that measurements be made along curved lines." The layman will no doubt exclaim, "Well, I thought they were offering me a camel to swallow, but it turns out to be only a gnat." For, of course, we can make measurements in space in any way we like. From time immemorial astronomers have measured the course of a planet or comet traveling along its orbit, be it an ellipse, parabola or hyperbola. It hardly required the insight of an Einstein to discover that fact.

To make matters still clearer Professor Seares brings up the time-honored illustration of measuring distances along the earth's surface. Of course we would naturally measure the distance from Pasadena to New York on a great circle, or more likely by the actual route traveled by our railroad train—a decidedly crooked path. But suppose we wished to use this distance as a base line to find how far away the

moon is, we should then have to measure the chord connecting the two places—a straight line.

The gist of Professor Seares's remarks then seems to be that by discarding the straight line and making our measurements in space along curved lines we can "win the game with a score we could not otherwise attain." Curved lines, however, imply the existence of straight lines, and some of us still believe the game can be won by straight measurements and straight thinking.

JERMAIN G. PORTER

CINCINNATI, OHIO

CONICAL SNOWFLAKES

WITHIN the writer's observation, at least, a very unusual snowfall occurred in Ann Arbor on Sunday afternoon, April 26, 1931; during the afternoon three main falls occurred, each lasting for only a short while, and each yielding but little actual precipitation.

The crystal formation was that of a solid cone with a round base. The side of the cone made an angle of about 30 degrees with the axis. The round base was part of a spherical surface. The shape was exactly like that of a conical section of a sphere.

As nearly as the eye could see into the formation of a snowdrop, the whole structure seemed to be made up of conical needles, packed together, with the upper ends forming the pointed tip of the cone, and the larger lower ends forming the rounded base.

The density was very high; a handful of snow, slightly compressed, immediately formed soft ice. The ratio of snow volume to volume when compressed to ice without air included would hardly have been higher than four to one.

Hundreds if not thousands of individual snowdrops came under observation on a window sill; irrespective of size, from tiniest to largest, the crystals were of the same form. In spite of landing on the stone sill at high speed in the high wind, nearly all crystals were tough enough to retain their shape; such few observed crystals as were shapeless were almost certainly shapeless only due to damage from impact.

The shape of the snowdrops was the same in all three falls, although the three falls occurred from a half hour to an hour apart. Many large crystals fell; one of the largest, by actual measurement, was three eighths of an inch across the base.

The day was very gusty, with rapid changes in wind velocity. Wind velocity at times during the snowfall became very high. There were rapid alternations between brilliant sunshine and considerable cloudiness. The temperature was mild. Most of the snow would melt in a few minutes, although an inch or two that became piled on the running board of a car was there the next morning, partly melted, but with somewhat globular outlines still visible.

Observation of the shape of crystals was checked by Professor William Stout.

A. D. MOORE

ELECTRICAL ENGINEERING DEPARTMENT,
UNIVERSITY OF MICHIGAN

THE LABRADOR CURRENT AND ICEBERGS

I NOTICE on page 12 of the May 15th number of *Science Supplement* an article on "The Labrador Current and Icebergs."

In explaining this phenomenon it might be well to consult the Weather Bureau records at Key West and Havana with respect to the direction and velocity of the wind this winter as compared with normal winters.

It is my observation in the months of November, January and February that the usual northeast winds, referred to there as the "trade winds," were absent a great deal of the time and were replaced by northwest winds of very considerable velocity.

A northeast wind blowing counter current to the flow of the Gulf Stream at the south end of Florida would tend to slow down the Gulf Stream. If this atmospheric resistance to flow was eliminated one would expect the Gulf Stream to speed up and carry more heat to the north.

IRÉNÉE DU PONT

WILMINGTON, DELAWARE

THE IMMEDIATE PROBLEM FOR BIOLOGICAL ABSTRACTS

A VICIOUS circle exists in the affairs of *Biological Abstracts*. This publication finds difficulty in obtaining a maximum number of subscribers because it is incomplete and indices have been delayed; it can not become complete and indices be published without the financial support available directly and indirectly from a maximum number of subscribers.

Under the general conditions existing in the biological sciences, we can hope to pay by subscriptions only for printing and similar costs. Editorial costs must be met by some form of subsidy. These editorial costs are more than twice those for printing. Subscribers pay less than one dollar for each two dollars paid from other sources. The income from subscriptions is an important item in itself, but it is doubly important because it is the concrete evidence of the extent to which individual biologists are contributing their share to the undertaking. Nothing is so vital to the obtaining of permanent endowment for the editorial work of the *Abstracts* as a substantial increase in the subscription lists within the next twelve months. There are now three thousand subscribers. There should be five thousand.

Subscriptions are also important at the present time because printing costs must be paid by subscrip-

tions. The 50,000 abstracts in hand editorially for the year 1931 and the indices in arrears can not all be published without more money from this source. Every dollar received from additional subscriptions will count toward current publication as well as in support of the solicitation of permanent endowment for editorial costs.

A campaign of publicity and of advertising for subscriptions is being initiated, but thirty societies in a union present a difficult problem as compared with the situation of the chemists with a single society. The Union of American Biological Societies has undertaken to support this campaign as the most effective means of increasing the subscription list. Thus, editorial costs are paid by subsidy, printing by subscriptions, and selling costs in the present emergency will be paid by the union. The funds of the union are derived from contributions by member societies. These funds must be voted, and most of the societies do not have business or executive committee meetings until next December. Hence we are especially in need of every dollar that can be obtained within the next six months. The original financing of the union came in part by contributions of from one to ten dollars from individual biologists. It is thought that many will wish to contribute in the present emergency. Checks should be sent to A. L. Quaintance, treasurer, Silver Spring, Maryland. The officers of the union also urge every biologist to use his best efforts in securing additional individual subscriptions at $9.00 and institutional subscriptions at $15.00.

W. C. CURTIS
F. E. DENNY
A. L. QUAINTANCE
I. W. BAILEY
C. W. GREENE
A. F. WOODS
Executive Committee, Union of American Biological Societies

REPORTS

COMMITTEE ON EFFECTS OF RADIATION UPON ORGANISMS OF THE NATIONAL RESEARCH COUNCIL

THE organization and initial activities of this committee were reported in SCIENCE, January 4, 1929. A statement of its policies and of assistance rendered to investigators during the first two fiscal years of its existence, 1929–30 and 1930–31, may now be recorded.

The general policies announced in the report above cited have been in practice with modification of details as experience has shown desirable. The funds are handled by the methods current with the Research Council. Investigators have been informed and applications invited by periodic advertisement in SCIENCE, as with the National Research Council Fellowships and by other justifiable publicity. Reports of progress and copies of published papers are submitted annually for current information of the committee by each investigator assisted. On March 1, 1931, there were 27 titles thus recorded.

Although dealing with the effects of physical agencies, the committee has been composed of individuals who are primarily biologists. The advice of physicists has been sought informally as seemed desirable. For purposes of cooperation, the addition of a physicist recommended by the Division of Physical Sciences of the Research Council has been arranged. By this means we shall obtain advice that is often needed and also cordial support from another division of the council.

Donations of money totalling $25,000 per year by the Commonwealth Fund and the General Education Board and gifts of money and apparatus were mentioned in the earlier statement. Experience shows that for legal and practical reasons large sums of money can not be expected from manufacturing organizations for work of this character. The current industrial depression is also a deterrent factor. Nevertheless, the committee has received $6,300 from this source. It is another matter with apparatus. This has been freely donated, and there is a list of over twenty-five cooperating industrial organizations. These contributions of apparatus are received in various ways now that the system is well in action. Under one arrangement the donation is outright and title to the apparatus rests with the Research Council. Assignment is made year by year with the expectation that title will ultimately be transferred to some institution where the use will be permanent and effective. In other cases the manufacturers loan directly to the investigator upon recommendation of the committee for as long a period as may be required. This method is simpler in administration since it does not involve the Research Council in matters of title and consequent responsibility. Or the manufacturer may donate to the institution in which the investigator is located. In practice it has been found impossible to keep an exact account of the apparatus made available under these diverse conditions, but it represents a large sum and there is reason to believe that support of this nature will be forthcoming throughout the period of the committee's activities. In addition to assignment of apparatus there is often opportunity to introduce investigators to the research laboratories

of industrial establishments from which advice and other assistance may be given.

The efforts of the committee with regard to apparatus are being directed not only toward the furnishing of needed equipment to the individual, but toward its more economical and effective use. Biologists often encounter difficulties in the operation of complicated physical instruments. These should really be in the hands of physicists and technically trained physical rather than biological assistants. The x-ray apparatus at the Marine Biological Laboratory is an example. For several years this was in charge of a biologist who had special qualifications. It was as well managed as could have been expected by one not a physicist, but the operation of such apparatus at the seashore is troublesome and during the summer of 1929 increasing difficulties were encountered. In 1930 it was possible, by a cooperative arrangement, to place the apparatus in charge of Dr. Failla, of the Memorial Hospital in New York City. During June, July and August, Dr. Failla was in residence at Woods Hole as an investigator and as an adviser to those who desired his assistance in the use of radium or x-rays. The arrangement will probably be continued by the committee in 1931.

Assistance in both apparatus and money is given to individuals rather than institutions, but the importance of the Marine Biological Laboratory and the Cold Spring Harbor Biological Laboratory as centers to which investigators are drawn is such that these institutions may be considered apart. With Dr. Fricke at Cold Spring Harbor throughout the year and Dr. Failla at Woods Hole during the summer, many investigators can be served in the manner indicated. The committee has, therefore, felt it desirable to support these two laboratories in every way possible by grants of apparatus and the manufacturers appear to be quite appreciative of the situation.

In considering the relative merits of different investigations it was felt that something like a "survey" of the present status of research upon the effects of radiation upon organisms might be undertaken for the better guidance of our subcommittee on allotment and for information of the standing committee in any solicitation of additional support or other contacts. A subcommittee on survey was accordingly established and brought together in March, 1930, in Washington. As the field is diversified this subcommittee includes the following general interests:

Genetics: A. F. Blakeslee, Carnegie Institution; L. J. Stadler, University of Missouri.

General Physiology: Janet H. Clark, Johns Hopkins University; Max Ellis, University of Missouri; S. O. Mast, Johns Hopkins University.

Development: E. E. Just, Howard University.

Plant Physiology: C. Stuart Gager, Brooklyn Botanic Garden; W. W. Garner, U. S. Department of Agriculture; H. W. Popp, Pennsylvania State College; B. M. Duggar (*chairman*), University of Wisconsin.

On the zoological side this subcommittee divided the field in the manner indicated, and on the botanical side into four divisions for problems especially related to plants. It was thought that the most satisfactory way to begin such discussion would be to bring together as advisers to the subcommittee investigators in the several fields, but to do this at a time when other business was not at hand would be expensive. A meeting of such individuals interested in *development* was held at Woods Hole in August, 1930, without expense. On November 1 and 2, 1930, a meeting for *Genetics* was held in St. Louis, through generosity of the General Electric X-ray Corporation. With a few exceptions this meeting, which lasted a full two days, was attended by all the leading investigators in this country now interested in the effects of radiation upon heredity. Although the meeting resolved itself into accounts of each man's work, followed by informal discussion, and was seemingly more profitable to the individuals concerned than to the committee, there has resulted a clarification with reference to future distribution of support and there seems no question of the stimulus to the participants, since they exchanged ideas in a way that is never possible at the annual meetings of a scientific society.

For *General Physiology* a meeting was held in Washington on November 8. In this case the financing was provided by joint contributions from the General Electric, Cooper-Hewitt, Westinghouse and Burdick Companies. It was attended by about thirty individuals, including representatives of clinical medicine and of the manufacturers. Here again individuals discussed their work, although in more general terms than the geneticists. The effects of x-rays and radium and of ultra-violet light were especially considered. The latter problem is of great interest to manufacturers at the present time because there is no adequate evidence from animal experimentation to support the belief of many clinicians in the efficacy of ultra-violet in general therapy, although in the specific instance of rickets these rays are unquestionably effective. If it can be shown beyond question that ultra-violet thus affects the general health and resistance of human beings, there are great possibilities for its commercial exploitation in artificial illumination. Some of those present, whose competence could not be questioned, felt obliged at this meeting to tell our friends among the manufacturers that the experimental evidence on animals is still inconclusive, save in the case of rickets, and that clin-

ical interpretations of results on human beings are open to serious criticism. But there remains a residue of clinical observations that justify further study, alike for their scientific importance and for their commercial possibilities. The fact that so wide a range of wave-lengths have been involved in most research upon effects of ultra-violet light may account for conflicting observations, if it can be shown that some wave-lengths in this series are beneficial to man and the higher animals while other lengths are ineffective.

For *Plant Physiology*, meetings were made possible in Washington on March 14 and 15, 1930, by the committee on grants-in-aid of the Research Council, with an attendance of about twenty-five individuals. The results of the discussions in all these gatherings will be assembled for the confidential use of the committee on radiation and for other purposes, including, no doubt, ultimate publication of certain derivative material of value to investigators.

Grants during the period of January 1, 1929, to June 30, 1931, may be summarized as follows:

Some 32 investigators have been assisted with money and many of these have also received apparatus; 9 have received apparatus only; 4 have been loaned for extended periods the 125 milligrams of radium placed at our disposal by the Radium Chemical Company; 17 of the above 32 investigators received grants for both 1929–30 and 1930–31; 15 received a grant for only the first of these years or for the first time in 1930–31. The total amount of these grants to June 30, 1931, is $53,315.73. The amounts in single grants during the two and one half years since January 1, 1929, include: 1 for $2,100; 8 for $2,000; 4 for $1,800; 1 for $1,750; 1 for $1,170; 1 for $1,600; 1 for $1,500; 1 for $1,250; 2 for $1,200; 4 for $1,000; 2 for $900; 3 for $800; 6 for $750; 5 for $500; 1 for $400; 6 for $300; 1 for $200; 1 for $150; 2 for $100.

In preparing this statement attention has been drawn to the titles listed on the program of the principal organization of American geneticists at the scientific meetings in Cleveland, December 29, 1930, to January 2, 1931. Papers by individuals who have been substantially assisted by the committee constituted a relatively large fraction of this program. In addition to Blakeslee, Muller, Patterson, Stadler, Weinstein and Whiting, there appear the names of several students introduced by these individuals. This may be cited as an example of the wide-spread influence of the committee in one of the principal fields in which it is supporting investigation.

W. C. CURTIS,
Chairman

SOCIETIES AND ACADEMIES

THE IOWA ACADEMY OF SCIENCE

THE forty-fifth annual meeting of the Iowa Academy of Science was held at Davenport, Iowa, at the Davenport Public Museum and Saint Ambrose College on May 1 and 2 with 203 members and visitors in registered attendance.

The president's address, "Some Remarks on Mathematical Statistics," was given by Dr. H. L. Rietz, of the State University of Iowa, after a welcome by Mr. E. K. Putnam, the director of the Davenport Public Museum, and Fr. Martin Cone, president of Saint Ambrose College. The address, presented by the academy to the citizens of Davenport, was made by Dr. M. F. Guyer, chairman of the department of zoology at the University of Wisconsin, on "Internal Secretions and Human Well-being."

A grant from the academy research fund was made to Professor H. E. Jaques to help carry on an entomological survey of the State of Iowa.

The academy approved the organization of a junior academy of science, composed of high-school science clubs, which would be affiliated with the senior academy. A provisional constitution was approved and the furtherance of the movement was placed in the hands of a committee on high-school relations.

Officers and section chairmen for the year 1931–32 were elected as follows:

President, J. E. Lees, Des Moines.
Vice President, H. E. Jaques, Mt. Pleasant.
Treasurer, W. F. Loehwing, Iowa City.
Editor, G. H. Coleman, Iowa City.
Secretary, J. C. Gilman, Ames.
Representative of the American Association for the Advancement of Science, C. W. Lantz, Cedar Falls. The new chairmen of sections are: Botany, G. W. Martin, Iowa City. Chemistry, inorganic and physical, T. H. Liggett, Pella. Chemistry, organic and biological, H. A. Mattill, Iowa City. Geology, E. J. Cable, Cedar Falls. Mathematics, C. W. Strom, Decorah. Physics, T. C. Poulter, Mt. Pleasant. Psychology, T. F. Vance, Ames. Zoology, R. L. Abbott, Cedar Falls.

Botany Section: E. W. Lindstrom. Twelve papers were presented before this section, some of which were of sufficient general importance to merit attention. W. E. Loomis and K. H. Burnett reported on the photosynthetic efficiency of maize, using field plants from which certain parts (leaves or ears) were removed. Soil aeration of experimental plants was found by W. F. Loehwing to exercise a profound effect on root growth and on general plant growth

and maturation. J. M. Aikman discussed the microclimate of maize in relation to other ecological factors in field plants. Tetraploid tomatoes derived from three different genetic sources were shown to possess differential fertility (pollen and seed formation) dependent upon their chromosomal makeup. A true-breeding tetraploid tomato was also reported by E. W. Lindstrom. I. E. Melhus gave a comprehensive résumé of recent advances in corn disease investigations. J. C. Gilman and E. M. Summers reported on the thermogenic capacities of some fungi from heating corn. Three mycological papers, largely of taxonomic interest, were presented by G. W. Martin, Ella Baskerville and Marion C. Fisher. Notes on Iowa mosses by Lucy M. Cavanagh were read. An ecological study of glacial relict plant communities was presented by H. S. Conard. The sessions closed with a round-table discussion on teaching botany, led by S. M. Dietz.

Chemistry, Organic and Biological: L. Chas. Raiford. The program of the section of organic and biological chemistry listed 10 papers, which included the results of researches that have been in progress during the past year in several of the laboratories of schools and colleges in Iowa. The section was in session Friday afternoon and Saturday morning. By vote of the group two papers not listed on the program were presented at the Saturday morning session. The attendance was large and the reports called forth considerable discussion. The chairman selected for the coming year is Professor H. A. Mattill, of the State University of Iowa.

Geology Section: L. W. Wood. The program of the geology section included an unusually large number of papers of general interest to all parts of the state. Two papers by G. F. Kay on classification and duration of the Pleistocene were outstanding in the importance of new material presented in them. Papers by A. C. Tester and N. C. Georgeson dealt with certain phases of the stratigraphy of the Cretaceous System in western Iowa and the adjoining portions of the adjacent states. A paper by Paul T. Miller on the "Iowan Gravels in Northeastern Iowa" was well received and provoked considerable discussion. Mark Morris delivered a paper on "Unsoundness of Certain Types of Rocks," pointing out the importance of this characteristic as affecting their serviceability in structural uses. A. C. Tester presented evidence of a case of contemporaneous deformation in the Cedar Valley Limestone. G. F. Kay gave an explanation of a possible method of formation of the "Peble Band" often found on the surface of the Iowan Till. The final paper was a discussion by James H. Lees of the extremely interesting section obtained in the Clarinda oil prospect drilling. Five other papers were read by title in the absence of their authors. The section meeting was attended by a group of about thirty people.

Mathematics Section: John F. Reilly. The twentieth regular meeting of the Iowa section of the Mathematical Association of America was held in conjunction with the forty-fifth meeting of the Iowa Academy of Science. A program of nineteen papers was presented, a majority of which treated of some phase of theoretical or applied statistics. The retiring chairman, Professor George W. Snedecor, gave an address on "Standard Deviations of Standard Regression Coefficients." Officers for the coming year were elected as follows:

Chairman, Carl W. Strom, Luther College.
Vice Chairman, Byron D. Roberts, Parsons College.
Secretary, John F. Reilly, University of Iowa.

Psychology Section: E. O. Finkenbinder. About 75 workers in psychology discussed 30 studies of exceptional interest to all. Harry A. Green's paper evaluated Iowa University's new technique of recording speech so as to study it objectively. Dean Seashore presented a new scientific musical staff that indicates exactly when a tone is produced, the length of time it is held, its intensity, and its timbre, all mechanically produced. Seven other papers on the psychology of music were presented, among which were: hearing the vocal vibrato, by Harold Seashore; the vibrato of stringed instruments, by Scott Reger; an artistic pianogram, by Miss Laila Skinner; an analysis of intensity in piano playing, by D. A. Rothchild. There were two papers on art and three on attitudes of delinquents as compared with normals. E. O. Finkenbinder showed that twice as much information learned from scored quizzes composed of direct questions was remembered for six weeks as that learned from scored quizzes made up of true and false statements. B. F. Zuehl showed that students prefer objective tests as motivation for their study. F. B. Knight's paper indicated that the position of a given combination of numbers in a problem influenced its difficulty greatly. J. W. Charles pointed out that upper classmen receive the higher marks. E. O. Finkenbinder's tabulation of the amount of absence since the beginning of the century at the State Teachers College showed that the amount of absence was cut from 2.2 per cent. per pupil that existed before the rule was adopted in 1916 that deducts one tenth of a credit for each absence not excused, to 1.2 per cent. after the rule went into effect; and that the percentage of pupils who were in perfect attendance per term was raised from 42 to 69—more than a 50 per cent. gain in regularity due to the rule. E. C. Denny found that the Ayres spelling scale has some words in a column that are much more difficult than others. Miss Gertrude Cox indicated that the Ames psychological tests predict college success.

Clelland Morgan presented two papers on learning, and C. A. Ruckmick gave some recent improvements in galvanic technique.

Zoology Section: H. E. Jaques. The program, while utilizing only one half day, covered a range of interests almost as wide as the zoological field. Two papers were taxonomic, Robert L. King describing new protozoans of the genera *Vorticella* and *Thecacineta,* and Owen Smith illustrating some thirty species of *Tenebrionidae* known to occur in Iowa and providing a key for their identification. Records of golden and bald eagles as well as some other rather unusual birds which have been seen recently in southeastern Iowa were presented by Pete Parks, while F. L. Fitzpatrick showed that raptorial birds rather frequently possess bilateral ovaries. William T. Levine found the ovaries of frog tadpoles to degenerate when treated with x-ray. In a study of the hormone influence on the reproduction functions of parabiotic female rats Robert T. Hill reported the corpus luteum hormone stronger and more positive in action than the oestrous producing hormone, and E. W. Shrigley told of a marked difference in the susceptibility and resistance to anaphylactic shock in guinea-pigs and discussed methods of selecting. H. E. Jaques explained some methods used in conducting field contests to increase student interest in biological subjects, while Elizabeth Blagg displayed an exceptionally large earthworm and aroused a likely discussion as to the size and abundance of these creatures. Much interest was taken in Roy L. Abbott's recital of some almost human-like readjustment made by the golden digger wasp when its established routine was interfered with by the experimenter.

JOSEPH C. GILMAN,
Secretary

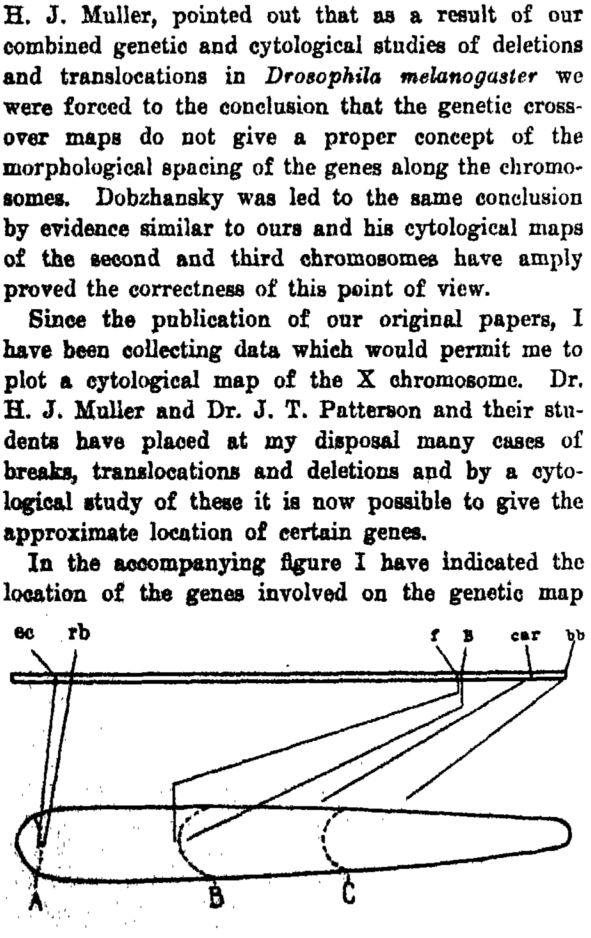
SPECIAL ARTICLES

A CYTOLOGICAL MAP OF THE X-CHROMOSOME OF DROSOPHILA MELANOGASTER

SEVERAL years ago the writer, together with Dr. H. J. Muller, pointed out that as a result of our combined genetic and cytological studies of deletions and translocations in *Drosophila melanogaster* we were forced to the conclusion that the genetic cross-over maps do not give a proper concept of the morphological spacing of the genes along the chromosomes. Dobzhansky was led to the same conclusion by evidence similar to ours and his cytological maps of the second and third chromosomes have amply proved the correctness of this point of view.

Since the publication of our original papers, I have been collecting data which would permit me to plot a cytological map of the X chromosome. Dr. H. J. Muller and Dr. J. T. Patterson and their students have placed at my disposal many cases of breaks, translocations and deletions and by a cytological study of these it is now possible to give the approximate location of certain genes.

In the accompanying figure I have indicated the location of the genes involved on the genetic map



and below this an outline drawing of a typical X chromosome with lines to show the position morphologically of the points which have been determined.

Beginning with the so-called left hand end of the X chromosome (left in the figure), this winter Patterson obtained a break in the X chromosome between the loci for echinus (5.5) and ruby (7.5) and this segment became attached to one of the fourth chromosomes. (See Patterson and Painter in a recent issue of this journal for genetic and cytological evidence). Morphologically this piece which carries at least 5.5 genetic units (but does not extend to 7.5) is about three times as large as a normal fourth chromosome. The estimated proportional size of this segment is indicated on the schematic X chromosome by the line A, and since echinus is carried by the translocated piece and ruby is not, these two loci must lie to the left and the right of the line A, respectively.

Recently, Mr. Wilson Stone, a student of Dr. Muller, obtained a break in the X chromosome between the loci for forked (56.6) and bar (56.8)—genetic data unpublished—and the segment from the left hand end which must thus carry at least 56.6 genetic units was translocated to a fourth chromosome. This case was studied cytologically in females carrying a normal X and the two pieces of the broken X, and also in females hyperploid for the bar-carrying piece. The piece of the X chromosome which carries bar was found to be about three fourths the size, in length and volume, of the normal X chromosome in the same cell, and the piece which was translocated to the fourth chromosome is about a fourth the volume of the normal X. On the figure the length of the bar segment is indicated by the line B. The locus for

bar must be to the right of this line, and forked as well as the 56.6 genetic units from the left end must lie to the left of the line B.

In one of the first deletions studied genetically by Muller and cytologically by the writer, there were at least 64.5 genetic units missing from the X chromosome [the locus for prune (1) but not white (1.5) was present; the locus for carnation 65.5 was lacking but bobbed (70) was present] and this deleted X was about a third of the normal X chromosome in size. At the time of these earlier studies we did not know what proportion of the deleted X was due to the left and right hand ends respectively, but in view of the recent finding that only the tip of the left hand end is involved morphologically when 5.5 genetic units are missing, it is clear that the size of the deleted X must have been due almost entirely to the right hand end segment. The size of the deleted X is shown on the figure by the line C. Since carnation (65.5) is not present in this deleted X it follows it must lie somewhere to the left of the line C but to the right of the bar locus and that bobbed, which is present, must lie to the right. From the nature of the evidence, we can not locate carnation or bobbed more accurately at present than as indicated above, but in view of the location of ruby and of bar, one might guess that carnation would lie much closer to the bar locus than the line C.

An analysis of other cases, the data for which we can not give in this brief article, fits into the cytological map as here given. Complete cytological evidence and pertinent discussion will be presented in a longer paper now about ready for press.

T. S. PAINTER
THE UNIVERSITY OF TEXAS

THE STRUCTURE OF PROTOPLASM

INSUFFICIENT optical differentiation between the constituent parts of protoplasm has greatly hampered the advance of knowledge of protoplasmic structure. Dark-field illumination with the cardioid condenser has helped but little. The recent invention of a dark-field oil-immersion objective by Charles Spierer[1] is a very successful forward step in indirect illumination methods, especially when applied to the study of the colloidal structure of living matter. The Spierer lens reveals a structure in living protoplasm, as it does in celloidin[1] and in the cellulose walls of plant cells,[2] which is not visible with any other optical system.

The Spierer lens is a Zeiss 1/12 inch oil-immersion objective with a small platinum mirror electrolytically deposited at the center of the upper surface of the lowermost lens of the objective system. This mirror reflects all direct light, thus producing a dark-field. The scattered (colloidal) light from the object viewed is picked up by the lens around the mirror. Increased detail results because direct light is used instead of the usual bilateral illumination of the older type of ultramicroscope. The optical principles involved and a fuller description of the lens are given in other publications.[1, 2]

When the hyaline protoplasm of living onion cells is viewed through the Spierer lens, it is, under favorable conditions, seen to consist of two substances, one brightly illumined, light gray in color, and very finely granular in texture, and the other, an optically empty, black background. In quiescent protoplasm these two substances are intermixed as an emulsion and then present a mottled appearance. Protoplasm under tension, as it is when formed into a thread (Fig. 1, a),

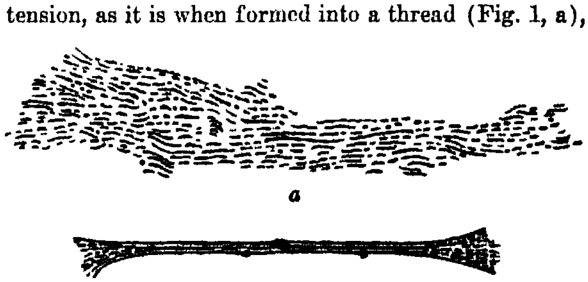


FIG. 1

or when streaming (Fig. 1, b), assumes a striated appearance, due to the parallel arrangement of long strands of the illuminated substance. These strands may be continuous (Fig. 1, a) or discontinuous (Fig. 1, b); in the latter case they are made up of rods oriented end to end. The striated structure is seen at its best in actively flowing protoplasm. Included particles occur, and appear as brilliant globules imbedded in either the gray matter or the dark intervening substance.

Without any attempt to characterize chemically or vitally the two phases which make up this dark-field structure of protoplasm, I propose calling the brightly illuminated, gray-appearing, and at times discontinuous, dispersed phase, the *phaneroplasm*, (*phaneros* = evident), and the unilluminated, black-appearing, optically empty background, or continuous phase, the *cryptoplasm* (*cryptos* = hidden). In the accompanying figure, the phaneroplasm is black and the cryptoplasm (the background) white, which reverses what is white and what is black in the actual material as seen with the Spierer lens.

Both phaneroplasm and cryptoplasm flow, though apparently not at the same rate, the phaneroplasm being more sluggish in its movement. The cryptoplasm is optically empty and can not, therefore,

[1] "Un Nouvel Ultra-microscope à Éclairage Bilatéral," *Arch. Sci. Phys. et Natur.* (Genève) 8: 121, 1926.

[2] "The Spierer Lens and What it Reveals in Cellulose and Protoplasm," *Jour. Phys. Chem.* 118: 35, 1931.

actually be seen; its streaming is, however, made evident by the movement of included particles. A rapidly moving particle may, where there is an irregularity in the arrangement of the striae, strike against the side of a strip of phaneroplasm; its forward movement is thus retarded, but only for a few moments while it is slowly pushed through the phaneroplasm, first thinning it, and then breaking through. This and other similar events indicate that *the cryptoplasm is the actively streaming component of protoplasm.*

The strands of phaneroplasm are from 0.3 to 0.4 μ in thickness and 0.2 to 0.3 μ apart.

Except for the optical properties already referred to, there is little to be said concerning the physical, chemical and vital nature of the two substances which make up the living hyaline diphasic system. The phaneroplasm is brightly illuminated but the cryptoplasm is not. Where the protoplasm, at rest, assumes a mottled appearance, the phaneroplasm becomes the dispersed phase and the cryptoplasm the dispersion medium of an emulsion; where the protoplasm is striated but the striae broken, the structure is still that of a (distorted) emulsion; but where continuous striae exist, there is no distinction between a discontinuous and a continuous phase, that is to say, there is no emulsion as ordinarily defined.

New terms are convenient if merely as temporary handles to be discarded as knowledge of the subject increases, but they add confusion if satisfactory old terms exist. Strasberger[3] distinguished between kinoplasm (active substance) and trophoplasm (nutritive substance), two terms which have been brought into use again by Lloyd and Scarth;[4] but these terms are not applicable to the cryptoplasm and phaneroplasm described here if Strasberger's original description is to be adhered to. He says that kinoplasm possesses a fibrous structure and trophoplasm the structure of a honey-comb, and that the two substances may be in quite distinct regions of the cell. No such differences are evident in the dark-field structure of protoplasm as seen by the Spierer lens. This lens differentiates not kinoplasm from trophoplasm, but two substances which make up the kinoplasm alone.

There does not appear to be any satisfactory correlation between the structure of actively flowing hyaline protoplasm as revealed by the Spierer lens, and structures seen and described before. The mottled emulsion structure of the resting protoplasm is, in a broad way, comparable to alveolar protoplasm as described by Bütschli, and to numerous other pseudo-alveolar, vacuolate and emulsion structures. The striated structure of protoplasm when under tension, has apparently no counterpart in the older literature.

The nearer we approach the ultimate structure of protoplasm the less easy it is to differentiate between the relative importance of its constituents, but the idea that some substances in living matter are more important than others is often entertained. If we attempt to draw a distinction between the relative "vital" significance of phaneroplasm and cryptoplasm, then, frequent discontinuity in the former and active streaming of the latter suggest that cryptoplasm is the more fundamental of the two.

WILLIAM SEIFRIZ

DEPARTMENT OF BOTANY,
UNIVERSITY OF PENNSYLVANIA

[3] "Ueber Cytoplasmastructuren," *Jour. wiss. Bot.* 30: 375, 1897.

[4] "The Rôle of Kinoplasm in the Genesis of Vacuoles," SCIENCE, 65: 599, 1927.

ON A POSSIBLE EFFECT OF FUNGICIDES UPON THE COMPOSITION OF APPLES

THERE is prevalent among the practical fruit-growers of the Annapolis Valley district of Nova Scotia the opinion that apples sprayed with sulphur fungicides do not keep as well in common storage as those sprayed with copper fungicides. Actual storage comparisons have not, however, indicated any marked difference in the rate of senescence of fruit treated with these respective fungicides as evidenced by the rate of fall of the pressure test, by the appearance of the fruit, or by its rate of spoilage. One of the workers, at present actively engaged in making storage tests of this nature, has, nevertheless, found differences in flavor sufficiently marked to enable him to differentiate (by blindfold test) unsprayed fruit from that which has been treated during the growing season with sulphur or with copper fungicides. This fact indicates that there may actually be a difference in composition induced by the repeated use of these respective fungicides during the growth period of the fruit.

In an attempt to obtain evidence of such differences the authors have recently made analyses of apples of the Northern Spy and Ribston Pippin varieties which had received various fungicidal treatments. Samples of five apples each of the former variety and of ten apples each in the case of the latter were selected from quantities of fruit gathered in connection with a study (in progress) of the amounts of sulphur and copper remaining upon the fruit at harvest under Nova Scotian conditions. This fruit had received uniform storage treatment of the common storage type since date of picking, and all samples were gathered at practically the same stage of maturity. The apples were quartered, the stems and cores removed, and the remaining tissues finely ground in a common food chopper. Samples of 25 grams each were weighed out as soon as possible after thorough mixing of the

mass of pulped tissue, and killed by dropping into sufficient boiling 95 per cent. alcohol to make the final alcohol concentration about 80 per cent. The sucrose equivalent of the total reducing power of the alcoholic extract, and of the extract obtained by hydrolyzing the alcohol-insoluble residue for one and one-half hours with a 3.6 per cent. solution of hydrochloric acid, were determined by the cuprous chloride-iodine method.[1] Aliquots of the alcoholic extract were also titrated for acidity. The variations in acidity were, however, small and showed no definite trend. In the case of the reducing power of the alcoholic extract, and also that of the alcohol-insoluble residue after hydrolysis, there was an indication that the fruit which had been treated with sulphur fungicides during the growing season possessed, at the time of the analysis (December 19, 1930, and January 3, 1931), a slightly lower reducing power than unsprayed fruit or fruit which had been sprayed with Bordeaux mixture. Particularly was this true when the sulphur treatments were considered as a group and compared with the check and copper treatments as a second group. The actual results are given in the accompanying table, where the values marked with an asterisk indicate the average result obtained for three samples, the others the average for duplicate samples.

Variety	Treatment	Sucrose equivalent: Alcoholic extract	Sucrose equivalent: Alcohol-insoluble-acid-hydrolyzable	Sucrose equivalent: Total
Northern Spy	Lime-sulphur	10.61*	1.11*	11.72*
" "	Lime-sulphur with ferrous sulphate	10.84	1.13	11.97
" "	Unsprayed	11.06*	1.16*	12.22*
" "	Bordeaux	11.24*	1.17*	12.41*
Ribston Pippin	Sulphur dust	10.90	1.25	12.15
" "	Lime-sulphur with aluminium sulphate	10.98	1.31	12.29
" "	Bordeaux	11.40	1.41	12.81
" "	Unsprayed	11.60	1.43	13.03
" "	Lime-sulphur	11.76	1.37	13.13
Average of all sulphur treatments		11.02	1.23	12.25
" " " other treatments		11.33	1.29	12.62

These results can not be considered as demonstrative of an actual difference in the composition of apples resulting from varying fungicidal treatment, the number of determinations being too few and the differences too small. They may perhaps be taken as indicating that further investigation of the problem is justified, and it is the intention of the authors to make a more detailed study as soon as time and opportunity permit.

W. A. DeLong
A. D. Pickett

[1] F. M. Scales, "The Cuprous Chloride-Iodine Method for Sugars Simplified," *Jour. Ind. Eng. Chem.*, 11: 747, 1919.

DIFFERENTIATION OF VIRUSES CAUSING GREEN AND YELLOW MOSAICS OF WHEAT

In previous papers[1,4] dealing with the wheat mosaic occurring in Illinois and Indiana, attention was called to severe yellow mottling, streaking or striping phases associated with dark green and light green mottled phases. Similar associations have been observed in natural field infections in Virginia and in North Carolina. It has been pointed out[1,4] that the Currell variety, selections of several other wheat varieties and Red Winter spelt develop yellow mosaic to some extent in the spring when the seed is planted out of doors in virus-infested soil in the autumn, whereas certain other varieties of wheat (Harvest Queen) when grown simultaneously in the same soil and in adjacent rows develop green mosaic, become dwarfed, producing a condition which has been termed rosette, and show only occasional traces of yellow mottling, striping or streaking.

Although these several expressions of the disease are influenced by the species and variety of the host plant, it has been considered[4] that a mixture of virus might be present in the soils under study and that the several types of hosts may differ in their susceptibility to distinct viruses.

To obtain information on this phase five successive series of inoculations were made. Except for slight modifications the procedure was that used in building up severe yellow mosaics on tobacco, tomato and *Nicotiana glauca*[2,3] (pp. 562–563). In the case of solanaceous species it is possible to cut the small yellow mosaic areas from the green mosaic regions and obtain sufficient virus for the inoculation of a large number of plants. Owing to the small size of wheat leaves and the difficulty of obtaining sufficient virus from the narrow yellow spots or streaks initial virus

[1] H. H. McKinney, "A Mosaic Disease of Winter Wheat and Winter Rye," U. S. Dept. Agr. *Bul.*, 1361, 1925.

[2] H. H. McKinney, "Virus Mixtures that May not be Detected in Young Tobacco Plants," *Phytopathology*, 16: 893, 1926.

[3] H. H. McKinney, "Mosaic Diseases in the Canary Islands, West Africa, and Gibraltar," *Jour. Agr. Res.*, 39: 557–578, 1929.

[4] H. H. McKinney, "A Mosaic of Wheat Transmissible to All Cereal Species in the Tribe Hordeae," *Jour. Agr. Res.*, 40: 547–556, 1930.

extracts were obtained, the yellow from a Red Winter spelt plant with medium yellow mosaic and the green from a Harvest Queen wheat plant with green mosaic. Both of these plants contracted mosaic from virus-infested soil transported to Arlington Farm, Rosslyn, Virginia, from the infested area near Granite City, Illinois. The virus extracts were obtained in the spring from whole leaves and sheaths or from portions of leaves showing the most intense green symptoms and from leaves showing the most intense yellow symptoms.

Healthy seedlings of Harvest Queen wheat and Red Winter spelt were inoculated with virus extract from the spelt plant with medium yellow mosaic. At the same time healthy wheat and spelt plants of the same varieties and ages were inoculated with extract from the wheat plant having green mosaic. This plant contracted the disease late and showed no rosette symptoms.

All inoculations were made according to the method described previously.[1] The plants were given eight hours daylight daily, and soil and air temperatures were held near 60° F. except during midday in sunny weather when the temperature usually went above 60° F.

Mosaic symptoms appeared in from two to ten weeks after inoculation, four to five weeks being the time required by the majority of the plants.

The results of the test on Harvest Queen wheat showed that yellow mosaic predominated in the plants inoculated with virus from yellow mosaic, and green mosaic predominated in those inoculated with virus from green mosaic. However, most of the plants showed some signs of both types, and typical rosette developed in most of the plants in both inoculations.

All Red Winter spelt plants produced yellow mosaic, but the yellow was more intense in the plants inoculated with virus from the plant with yellow mosaic. This variety of spelt never develops the rosette symptom.

Following the first test four additional successive tests have been carried out. In all these the yellow mosaic and the green mosaic viruses were obtained respectively from plants with the most pronounced yellow mosaic and the most pronounced green mosaic in the previous tests. As the work has progressed the green mosaic consistently has become more green and the yellow mosaic consistently more yellow.

In all tests after the first no rosette occurred in Harvest Queen inoculated with the virus of yellow mosaic, and in all tests after the second typical rosette occurred in all Harvest Queen plants inoculated with the virus of green mosaic.

In the fifth test only Harvest Queen plants were inoculated. Those inoculated with virus from yellow mosaic developed the most severe symptoms yet encountered in wheat mosaic. Soon after the first signs of the disease appeared many of the leaves became almost entirely yellow and these died quickly. Many plants died rather early. However, as the surviving plants continued slow growth the disease frequently became less severe. In these particulars the plants behaved like young tobacco and tomato plants inoculated with virus from the most severe forms of yellow mosaic originating from the common mosaic of tobacco[3] (p. 563).

The green and the yellow mosaics of the small grains do not always develop on all the tillers of a given plant and in certain varieties it appears that complete recovery from the disease occurs in some plants.

In the fourth and fifth tests the green mosaic symptoms were very mild in many of the plants, but the rosette symptoms were very typical.

It is clear from these experiments that the wheat mosaic under study represents a mixture of types which can be resolved into distinct yellow and green forms. This mixture occurs in both the yellow and the green types occurring in nature. The yellow type has been concentrated in relation to the green type and has been rendered very severe in its expression on a variety of wheat (Harvest Queen) which shows only slight traces of it in combination with green mosaic when infections occur naturally from infested soil or when artificial inoculations are made with virus from plants which became infected by way of the soil.

It is evident also that rosette is not associated with yellow mosaic on Harvest Queen wheat, whereas it is associated with green mosaic on this variety. The nature of the association between rosette and green mosaic must be studied farther. A single virus may cause both expressions or more than one virus may be involved.

A very faint trace of yellow mosaic still appears in a few Harvest Queen plants having the purified green mosaic. On spelt this yellow mixture is more evident, and on this account attempts to completely remove the yellow trace are being continued with spelt. However, it is possible that all traces of the yellow form can not be removed by existing methods as has been the case up to the present time with the common mosaic of tobacco.[5] Whether a trace of green mosaic is still associated with the purified yellow type on wheat can not be determined so readily.

H. H. McKinney

Bureau of Plant Industry,
U. S. Department of Agriculture

[5] H. H. McKinney, "Further Studies on Virus Purification," (Abs.) *Phytopathology*, 21: 118, 1931.

DISSOLVED PHOSPHORUS AND INORGANIC NITROGEN IN THE WATER OF THE MISSISSIPPI RIVER

IN 1921 McHargue and Peter[2] published some results of quantitative studies of the mineral plant-food in natural waters. In their studies were included samples of water from the Mississippi River at Minneapolis, Minn., and Baton Rouge, Louisiana. These authors found that the phosphorus expressed as P_2O_5 at these two stations amounted to 0.25 and 0.15 ppm respectively. From the method employed by them it appears that they determined the total phosphorus in the filtered water rather than the soluble phosphorus only. According to these authors nitrate nitrogen was absent from the Minneapolis sample but occurred in the Baton Rouge sample to the extent of 0.8 ppm. Ammonia nitrogen was apparently not determined in the Minneapolis samples; in the Baton Rouge sample it was present in small quantities.

The present writer has for some time been interested in determining what inorganic constituent of pond water may be the factor that limits plankton production and hence fish production. A rather extensive series of determinations of the principal forms of inorganic nitrogen, and of the soluble and the total phosphorus has been made on the pond waters at Fairport, Iowa.[3] The results of these studies point towards the soluble phosphorus as the limiting factor. Nitrogen as free ammonia and as nitrates was always present but there were times when the soluble phosphorus was completely exhausted. Since these ponds are supplied with water from the Mississippi River, it seemed of interest to determine the variations in these constituents of the river water. These determinations have not been made as regularly as may be desired, but still they give some idea of the amount of free ammonia, nitrates, organic nitrogen, and soluble phosphorus present in the water of the Mississippi River.

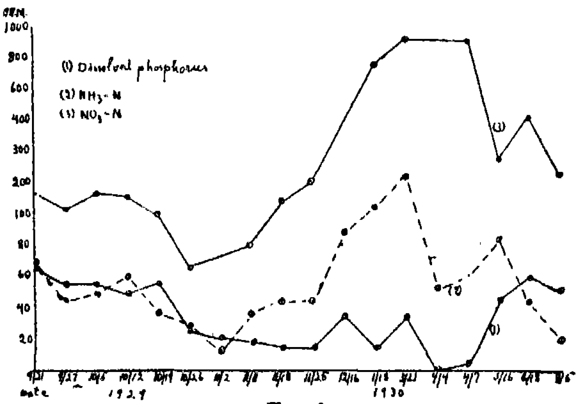


FIG. 1

The variations in the soluble phosphorus, nitrate nitrogen, and ammonia nitrogen for 1929–30 are presented graphically in Fig. 1 expressed in milligram per m³. Only the soluble phosphorus by Denige's method is shown in the graph. The total phosphorus was not regularly determined but 15 determinations on unfiltered surface samples gave an average of 0.136 ppm; 8 bottom samples gave an average of 0.173 ppm.

The soluble phosphorus varied considerably. The maximum for the surface samples occurred on Sept. 21, 1929, and amounted to .065 ppm; the maximum for the bottom samples occurred on June 18, 1930, and amounted to 0.082 ppm. The minimum for both top and bottom samples occurred on April 4, 1930. At this time the soluble phosphorus had been reduced to a trace. These minimum values occurred simultaneously with an enormous increase in the phytoplankton. This again points toward the conclusion that the soluble phosphorus may at times be a limiting factor. The range of the ammonia nitrogen in the surface samples is from a minimum of 0.012 ppm to a maximum of 0.224 ppm. In the bottom samples this form of nitrogen varies from a minimum of 0.020 ppm to a maximum of 0.184 ppm. Nitrate nitrogen in surface samples ranged from 0.051 ppm to 0.914 ppm and in the bottom samples from 0.060 ppm to 0.776 ppm.

On the basis of an analysis of 44 samples of water it is concluded:

(1) Inorganic nitrogen is apparently not a limiting factor in the waters of the Mississippi River at Fairport, Iowa.

(2) Soluble phosphorus may at times become a limiting factor.

A. H. WIEBE
U. S. BUREAU OF FISHERIES STATION,
FAIRPORT, IOWA.

[1] Published with permission of the U. S. Commissioner of Fisheries.

[2] J. S. McHargue and A. M. Peter, "The Removal of Mineral Plant-Food by Natural Drainage Water." Ky. Agri Ex. Sta., *Bull.* No. 237.

[3] A. H. Wiebe, "Investigations on Plankton Production in Fish Ponds." U. S. Bureau of Fisheries, *Doc.* 1082.

BOOKS RECEIVED

BAILEY, SOLON I. *The History and Work of Harvard University.* Pp. xiii + 301. 22 plates. McGraw-Hill. $3.00.

BILLINGS, J. HARLAND. *Applied Kinematics.* Pp. ix + 175. 154 figures. Van Nostrand. $2.50.

DUTCHER, DEAN. *The Negro in Modern Industrial Society.* Pp. xiv + 137. Science Press Printing Company, Lancaster, Pennsylvania.

LEYBURN, JAMES G. *Handbook of Ethnography.* Pp. vii + 323. Yale University Press. $5.00.

SHELTON, EDGAR G. *Architectural Shades and Shadows.* Pp. 159. 152 figures. Van Nostrand. $3.50.

VAN CLEAVE, HARLEY J. *Invertebrate Zoology.* Second edition. Pp. xiv + 282. 126 figures. McGraw-Hill. $3.00.

WILLIAMS, ROGER J. *An Introduction to Biochemistry.* Pp. xiv + 501. Illustrated. Van Nostrand. $4.00.

SCIENCE

VOL. 73 FRIDAY, JUNE 19, 1931 No. 1903

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE UNCERTAINTY PRINCIPLE[1]

By Professor CHARLES GALTON DARWIN

UNIVERSITY OF EDINBURGH

WE have seen that direct experimental evidence pointed to electrons being waves, in the sense that when we send a stream of them through two holes, we can only explain the result by supposing that, like a wave, each electron goes through both holes. We saw, moreover, that if a patch of wave-disturbance in a medium never encounters small obstacles it keeps together as it travels, and behaves in this way like an individual, which is what we think the characteristic of a particle. So we might at first sight be tempted to think that we had got a quite satisfactory and complete view of the character of an electron merely as being a wave of very short wave-length. But a little consideration shows that this will not do.

In the first place we have seen that though a patch of disturbance travels along as an individual with the definite group-velocity, there is always a region round its edges where the disturbance is slowly spreading. There is no way in which a wave can escape this gradual diffusion, and it means that ultimately it will become spread all over space. The rate of diffusion is smaller the larger the volume over which the waves are spread, so that it would be very slow for matter in bulk, and such waves would keep together a considerable time, but still they would not do so forever. Even if we regarded the world as originally created in well-defined "wave-packets," they would certainly by now have spread indefinitely. We may say that the existence of fossils which have preserved their form unchanged for several hundred million years disproves the adequacy of the wave theory.

But the matter is worse than this, since we can do other experiments which seem immediately to disprove the validity of the wave-theory. There exist substances which have the property of *scintillation*

[1] The fourth of the series of lectures on "The New Conceptions of Matter," delivered at the Lowell Institute on March 27, 1931.

when struck by electrons. A scintillating screen is made by lightly powdering a sheet of glass with zinc sulphide crystals; when one of these crystals is struck by an electron it emits a faint spark, which can be seen in the dark with the help of a magnifying lens. When such a screen is exposed to a stream of electrons, scintillations appear irregularly all over it. The natural inference from this experiment is that the stream is like a shower of rain falling on the screen, and each scintillation is produced when a single drop hits the screen. We seem to have a perfect and complete proof that the electrons are little bullets each traveling along a line from source to target.

It looks as though we had arrived at a flat contradiction. This experiment tells us that the electron is a bullet in one part of the stream, while we could not explain Thomson's experiments without supposing that the electron went through two holes at the same time, as only a wave can do. To bring out the contradiction still more strongly we may combine both experiments into one; though this experiment has not actually been done, there is not a shadow of doubt what would be found if it were practically possible. If we sent out a stream of electrons through two small holes close together and then looked for scintillations, we should find these still appearing as isolated sparks, but the sparks would all occur in certain bands, and none at all in between at the places where the diffraction theory predicts darkness. But if we afterwards block one of the two holes, we shall destroy the interference and shall get scintillations everywhere. The crude way of saying what has happened is that the electron stream was a wave when it was going through two holes, but has miraculously turned itself into a particle when it hits the screen. Of course such a description is not to be tolerated, since it would imply foresight on the part of the electron as to what was expected of it. We can imagine, for instance, that we could swindle the electron by pretending we were going to put a shutter with holes, so that it should get ready to be a wave, and then put a scintillating screen instead. Absurdities of this kind show that we have arrived at a very fundamental difficulty.

The elucidation of this contradiction is really the central point of the new quantum theory. The explanation, due to Heisenberg and Bohr, starts by showing that in fact the properties are not contradictory but complementary. Whatever the thing is that we call matter, it can be submitted to various experiments, some of which are devised to show wave properties and some particle properties; but if we devise an experiment which shows the wave properties, that experiment debars us from observing the particle properties at the same time, and *vice versa*. Suppose, for instance, that we wanted to make sure that it really was particles that were going through our holes. We should set a scintillating screen over one of them, and whenever we saw a scintillation we should say that there was a particle coming to that hole. But in doing so we should have prevented the particle going through and so obviously should not get interference on the other side. Next we might try to improve the experiment, by imagining our screen was so thin that the electron could produce a scintillation on it and still get through. Could we not then get interference between this part of the electron wave and the part that went through the other hole unimpeded? We should fail, because, though the electron wave has got through the first hole, the mere act of exciting the scintillation will alter the phase of its wave, and if this phase changes there can be no interference. We have laid a trap for the electron to induce it to tell us which hole it went through, but when the electron answers the question that it went through one hole, it automatically refuses to do the interference which would confess that it went through both.

It is the recognition of this and similar facts that has cleared up the mystery of the quantum theory. A situation arose rather like that in the early days of the discovery of relativity. The great idea which Einstein contributed to scientific philosophy was the principle that if a thing is essentially unobservable then it is not a real thing and our theories must not include it. He showed how the idea of absolute time was of this nature, and the whole beautiful structure of relativity was built up from that basis. But a self-consistent mathematical formulation of the theory is not enough; it is also necessary to convince ourselves by examples that in fact it really is impossible to determine whether two events in different places occur at the same instant. We learn to understand the theory much better by "shamming stupid," trying to lay traps for the theory and seeing how it escapes from them. Much the same state of affairs has arisen in the quantum theory; we have considered one case where we laid a trap for the electron, trying to make it tell us whether it was wave or particle, and we have seen how it avoided the trap. We must convince ourselves that no experiment can be invented which should at the same time require the electron to behave like a particle and like a wave. The guiding principle which establishes this result is called the uncertainty principle, and we shall discuss this and with its help shall see how the conflict between wave and particle is always avoided.

As we have seen, some experiments with electrons exhibit their particle characters and some their wave characters. We can not avoid thinking about both, and it is a very confusing thing to have to do. In

one picture the electron is a little speck of dust, or a bullet, and in the other it is, shall we say, like a stormy sea, and it is not easy to see much resemblance between the two. There have been attempts to regard it as a speck of dust *in* a stormy sea, but it can definitely be said that they are of no use at all. Perhaps the best description can be made by the use of a commercial expression; an electron is a particle "and/or" a wave. We must be ready all the time to think of it as either or both, but we must not mix the ideas. There are two half-worlds, each of which gives a partial view of the whole world; they are related to one another and interdependent, but they are expressed in different languages. We call the two half-worlds the particle aspect and the wave aspect. There is nothing of the same kind anywhere else in scientific thought, but the absolute separation, yet interdependence, can perhaps be compared to a similar separation in metaphysics. There is a close interdependence between the objective thing that we see or hear and our subjective sensation of sight or hearing, and yet the two use wholly different languages. When a string on the piano vibrates 256 times a second, we hear "middle C" without any conception that there is anything happening 256 times; and when an ether vibration with twenty thousand waves in each centimeter strikes our eye, we see yellow, an ultimate sensation giving no hint of a wave motion. In the same way, when we burn a finger in the objective world it is because the atoms of the fire are moving about a little faster than those in ourselves, but actually all we feel is that it is too hot. There is the same kind of interrelation without identity between the wave and particle aspects of matter. It is tempting to carry the analogy a little further, and to decide which way round it is to be taken. I think that it is best to regard the wave aspect as analogous to the objective world, and the particle to the subjective; for example, we have a very direct and intimate perception of what a particle means if we are hit by a bullet, and, on the other hand, we have no intuitive knowledge whatever that light and sound have anything to do with waves. But I do not in the least want to insist on this; the whole thing is only an analogy, and perhaps some will say a fanciful one. I am too bad a metaphysician to judge of this.

We must consider a little more closely the interdependence of the two aspects. In the last lecture we saw that it had been shown that under certain conditions the wave of an electron would have wave-length about the same as that of x-rays, that is about a hundred millionth of a centimeter. Thomson and others have experimented with electrons which, regarded from the particle aspect, have various speeds, and have found that the wave-length is inversely proportional to the speed; but the limitations of experimental technique prevent the investigation of any very wide range of speeds. Theory, however, clearly indicates what the relation will be between speed and wave-length; indeed the experimental work was really only a verification of the theory. The relationship was first given by de Broglie, and involves the *quantum* itself. The quantum is a certain universal constant which is always turning up in atomic theory. That it is a perfectly genuine quantity is shown by the fact that it has with some precision the value 6.545×10^{-27} gr. sq. cm per sec., but this does not really help any one to understand it. Its nature is best described by saying that it is the single universal connecting link between the particle and wave aspects. The rule for finding the wave-length of any particle is to divide the quantum by the momentum of the particle, and this gives the ultimate meaning of the quantum. The rule is true not only for electrons, but also for protons, atoms, molecules, photons and even bodies of ordinary large size.

In order to observe the wave aspect easily, we want to get long waves, and that means small momentum, and small momentum can be got either by having low velocity or else very light particles. For this reason most experiments on the diffraction of particles have made use of electrons, the lightest particles that exist. It is interesting, however, to note that recently the diffraction of whole atoms has also been observed. We will consider a few of the associated values for electrons of speed and wave-length, but in doing so, it must be strongly emphasized that we are describing the two irreconcilable aspects of matter as though they could be mixed together. When I say that such and such a speed implies such and such a wave-length, it is only to be taken formally. It means that if we have a suitable grating, lateral spectra will be found corresponding in position to that wave-length.

In Thomson's experiments the electrons were set in motion by an electric field of about 20,000 volts. This gives them the high speed of 8.5×10^{9} cm per sec., more than a quarter of the speed of light, which would carry them right round the earth in half a second. The associated wave-length is 0.8×10^{-9} cm, about a twentieth of the distance between the atoms in the analyzing crystal. In Davisson's experiments much lower voltages were used. With 200 volts the speed would be a tenth as great and the wave-length ten times as much, nearly as great as the size of the atoms of the crystal. For much lower voltages the experiments would become very difficult both because the electrons produce hardly any observable effect, and also because they will not be diffracted when their wave-length is greater than the interatomic distance. It is very probable that these difficulties will be overcome in time; indeed a beginning has already been made in that it has been found possible to observe

the diffraction of electrons, though still rather fast ones, with an ordinary optical grating instead of a crystal. Though experiments are lacking, theory predicts with confidence the wave-lengths associated with slower electrons. An electron moving at the speed of a rifle bullet has wave-length about a thousandth of a millimeter, a length visible in a microscope. An electron moving at the rate of ordinary human walking would have wave-length of a size just visible to the naked eye, and one moving at the rate of a rather slow tortoise would have wave-length an inch long.

These relations are so far only formal. We do not expect to be able to see the crests of the waves or anything of the kind, but are only maintaining that certain experiments, at present quite impracticable, would reveal diffraction effects which would imply these wave-lengths. But let us take the relationship more literally and see what it implies. An electron-particle moving at a rate of one centimeter a second is an electron-wave of length seven centimeters. Now a wave of seven centimeters does not by any means signify a wave with only two crests seven centimeters apart; it means an infinite train of harmonic waves stretching to infinity in both directions, with all the crests regularly arranged at intervals of seven centimeters. Where, then, is the electron particle? The answer is that it may be absolutely anywhere! This was the key to the elucidation of the whole quantum theory; it was entirely unforeseen and it is the central fact of the new conception of matter. Let us examine the question in more detail. Perhaps we have taken a rather too pedantic view when we say that the mere calculation of a wave-length implies that there was an *infinite* train of harmonic waves, for after all a train of waves with twenty or thirty crests travels for a time in much the same way and could show diffraction. Such a group or *wave-packet*, as it is often called in the present connection, travels along with the group velocity, but spreads a little as it goes. Where is the electron-particle now? The medium carrying the electron wave is undisturbed, except where the packet is, and so we can say that the electron particle is at all events somewhere in the packet, but we do not know whereabouts in it. The packet moves with the group velocity, and the electron must keep in the packet, so it must move at something of the same rate too. But now there enters the important point that a wave-packet always spreads, and so at a later time is longer than at the start, and therefore there is a wider region available for the particle-electron. This can be expressed in another way; we may say that the speed of the particle is not exactly the same as the group velocity of the waves but may be a little more or less. For example, if the particle is at the hind end at the beginning and at the front end of the wave later, when it has spread, then it will have gone faster than the group velocity. On account of the spreading of the wave-packet there is an uncertainty of the speed of the particle. The point of the new outlook is that though we think of a particle as associated with the wave, it is *impossible* to know where in the wave it is, and *impossible* to say exactly how fast it is moving. Our first tendency is to resist this conclusion and to say that we can imagine ways of finding where the electron really is and how fast it is moving. We shall consider this point soon, and show how such an experiment is always defeated, but it will be best to accept it for the moment, simply taking the rule that the particle-electron is somewhere in the wave-packet, and consider what degree of uncertainty of position and motion this implies.

The uncertainty of position of the electron depends on the size of the wave-packet, so that for a long packet, containing a great many crests, the position of the particle is very uncertain. Such a wave group on the other hand does not spread very rapidly, and so we can say that the velocity is rather precisely given. Next consider the opposite case of a very short wave-packet. In such a case the spreading is very rapid, so that the velocity is very uncertain. The general result thus is that the greater precision we demand for either position or velocity, the less the precision that can be assigned for the other. The rule is more definite than this, and can be given a rough numerical value. The product of the uncertainties of position and momentum of any particle can not be brought below a value equal to the quantum. This is true for all particles, electrons, protons, photons, atoms, and so on. It is the uncertainty principle.

The relation between wave-length and momentum is only one way in which the wave and particle aspects are connected. There is another which in many ways is quite as important, and which must be described. We may recall that the character of a harmonic wave depends on both wave-length and wave-velocity, and that from these two a third can be devised, the frequency, which is the number of oscillations per second described by the medium at a fixed point. The frequency is really the most fundamental of the three, for if the medium has variable properties the wave-length and wave-velocity will vary in different places, but the frequency will be the same everywhere. The frequency of an electron belongs of course to its wave-aspect, and the corresponding quantity in the particle aspect is the energy. The energy can be derived by multiplying the frequency by the quantum. There is also an uncertainty principle for the energy, just as there is for the momentum. This asserts that if we want to measure energy accurately we must take a long time in order to do so. If, on the other hand, we want to know the energy

at a certain moment, we must obviously only use a short interval of time round that moment to do the measurement, and the value we obtain will be inaccurate. It is easy to see why this should be so by taking account of the wave aspect. An accurate knowledge of the energy implies an accurate knowledge of the frequency, and this knowledge can only be attained by letting the oscillation run through a great many cycles, that is to say by taking a long time.

We have seen how the uncertainty principle arises quite naturally from the behavior of wave-packets. But we must now assure ourselves that no experiment can be devised which would directly determine both position and speed with a higher accuracy than the principle permits. In the first place a simple calculation shows that bodies of ordinary size, on account of their great weight, have so little uncertainty of velocity that the ordinary disturbances of the world will far exceed it. The effect only becomes perceptible for particles as light as atoms, and the most favorable case of all is the lightest particle, the electron. Let us therefore imagine that we have a skeptical experimenter, who refuses to believe in the wave theory, and sets to work to show that he can fix the position and speed of an electron at the same time with as high accuracy as he pleases. To make his experiment easier he will take the electron to be at rest, but it should be mentioned that this has nothing to do with the uncertainty principle; for that principle the difference between an electron at rest and moving at a centimeter a second is just the same as the difference between one moving at a thousand centimeters a second or a thousand and one. Our experimenter claims to have got an electron precisely fixed and at rest. We will cross-examine him about his work and see what he has found.

Q. How did you know the electron was there?

A. I saw it.

Q. An electron is a pretty small thing and not easy to see. How did you manage?

A. I had a microscope.

Q. Even a microscope can only see things of the size of a wave-length of light. You can't be much of a precisian if you say you knew exactly where it was from that. I thought you said you would guarantee to know *exactly* where it was.

A. Yes, but you see I had taken a course in optics at the University, and so I was not caught out as easily as that. I invented a special X-ray microscope. It has a wave-length of a thousand millionth of an inch. Of course there are the cosmic rays with still shorter wave-length, but nobody seems to know where they come from, so they would not be very handy. Any how I think I have done fairly well.

Q. Well, I haven't yet heard of an X-ray microscope on the market, but I suppose there will be one soon. Perhaps it would be pedantic to want you to do better. What did you see?

A. It was rather tiresome to get it going, but when I had done so an annoying thing happened. I knew the electron was there or thereabouts, because I had put it there; and it was at rest because otherwise it would have gone off while I was getting the microscope ready. Well, I was adjusting the microscope, and the electron was coming into focus beautifully, when it seemed to give a jump and run away. So that experiment was spoilt and I had to start again.

Q. Did you have better luck next time?

A. No. It was most curious; exactly the same thing happened every time. I think there must be something wrong with the microscope stage. I am going to have a shot to improve it. But as the microscope was certainly right in principle for seeing things to a thousand millionth of an inch, and as the electron stayed there all the time I was focussing it seems to me that I must be right. It is only a matter of overcoming the troublesome details that turn up in all experiments.

Q. It is not a matter of troublesome detail and there is nothing wrong with your microscope stage. Your trouble is not with the electron being there and staying there, it is with the seeing of it. You can't see the electron without light to see it by, and the light disturbs the electron and drives it away. It does not matter how many different experiments you design, you will always get caught out in one way or another. There is no escape from the uncertainty principle.

The old particle theory breaks down not because it is inconceivable to imagine a particle at rest at a definite place, but because every method that can be contrived to *observe* that it is there always introduces a disturbing element. The ordinary experiments with gross matter are made with instruments so designed that they do not perceptibly disturb the object measured. It would be a poor way of measuring the length of a stick to hit it with a steam hammer, and if we want to see what a microbe looks like we do not place it in the focus of a powerful burning glass. The measuring instrument is always chosen lighter or weaker than the object measured; but this can not be done when the object is the lightest thing that there is, an electron. In designing the experiment which is going to observe the electron we have to examine all its details so as to be sure that the method of observation is not going itself to introduce some disturbance. We do not of course expect anything as crude as the burning of the microbe, but we must estimate what effect there may be. We shall find that the effect exactly explains poor A's troubles, but in order to do so must make a digression.

It was known as early as the eighteenth century that all forms of wave exert a pressure on any obstacle that is reflecting them. This can easily be seen with a stretched string. Instead of tying the string to a support at the right-hand end, suppose that it

passes through a hole in a frame and is made fast somewhere beyond. The string just fits the hole, and the frame is held firm. When a wave of vibration travels along from the left towards the frame it can not pass the hole but is reflected back, forming "standing waves" with the hole as one of the nodes. Now consider the forces acting on the frame. The string has a bend at the hole (except at the moments when the phase of the wave makes it straight), and the frame has to bear the pressure of this bending. The direction of the force evidently bisects the angle between the string on the two sides of the hole, and so is nearly sideways, but not quite so, for the bisector must always fall to the right a little way behind the plane of the frame. The principal component of the force which is in the plane of the frame is alternately in opposite directions and so averages out; but the longitudinal component is to the right whether the vibrating part of the string is up or down, and so there is a residual force to the right on averaging. If we do not wish the frame to move, it will be necessary to hold it with a small force pushing towards the left, the direction from which the waves are coming. This means that the waves exert a pressure on the frame. More detailed consideration shows this pressure to be proportional not to the amplitude, but to the intensity of the waves.

It is found to be a universal rule that waves of every kind exert a pressure on an obstacle reflecting them. This must therefore be true of light, and the effect was predicted and many of its consequences were worked out long before the phenomenon was observed. The effect is very small indeed for any available source of light—the total force exerted by the sun shining vertically on a square mile of the earth is equal to a weight of about 3 lbs. The first attempt to detect the effect had a rather surprising result. Crookes made a little wind-mill with vanes blackened on one side and polished on the other. The polished sides reflect light, while the black absorb it. In consequence the force on the black side is half as great, for though it is receiving the wave it is not returning it. When exposed to a bright light, the radiometer should therefore go round with the black sides leading. It does go round, but the other way! This was ultimately traced to an effect of the irregular heating of the residual gas in the vessel; though very small it still far outweighs the minute direct effect of the light. It is only in comparatively recent times that this difficulty was overcome, first by Lebedev in Russia, and the actual pressure of light directly observed.

The pressure observed in this way is the gross pressure observed on the whole of a body in bulk. This must be regarded as the result of all the separate pressures on the atoms and electrons. The simplest inference that could be made was that each electron just took its proportional share of the whole. But with the development of the quantum theory it became possible to admit that this might not be so. If, for example, a few of the atoms got a violent kick and the rest none at all, the cohesive forces of the material would enable the few to drag the many with them, and the result in bulk would be just the same as though all the atoms had experienced a feeble force. This was the guiding idea in the very important discovery by A. H. Compton in 1922. From general considerations of the quantum theory as it then was, Compton put forward the idea that when light falls on an electron the process should be regarded as though it were a collision between two particles. Remember that this was before any one dreamed of the wave aspect for matter, and though the particle aspect of light was well known, no one before had ever dared to take it in anything like as literal a form. With the details of the Compton effect we shall be concerned in a later lecture. Here it suffices to describe the outline. When an electron scatters light it is thereby caused to recoil and the speed of the recoil depends only on the wave-length of the light and not at all on its brilliance. For visible light the recoil is feeble, but for x-rays it becomes very easily perceptible, and in fact Compton verified his theory in all its details by using x-rays. The only distinction between the effect of a bright light and of a faint one is that bright light will scatter an electron sooner than the faint, but the speed at which the electron goes will be the same in either case, provided the wave-length of the light is the same.

We may now return to our experiment with the microscope, and we know where the trouble lies. A microscope system consists of two parts, the condenser and the microscope proper. The condenser focusses light on the object, the object scatters it, and the microscope then refocusses into the eye. If we are to see an object, that object must have scattered light, and must itself recoil in consequence. So the mere fact that we see the electron guarantees that it is set in motion; even if it was at rest before we saw it, it can not be so afterwards. The mere carrying out of the experiment spoils the result aimed at. Notice that if we are content with knowing the position rather inaccurately we need not use light of a very short wave-length, and shall not then get much recoil; but if we want the position accurately, we must have a short wave-length and then the recoil will be large. So we see that the uncertainty principle is maintained; high precision in position or velocity can only be attained by the sacrifice of precision in the other.

We have seen how one method of defrauding the

uncertainty principle is defeated, but may there not be others that are more successful? Of course, the only way of proving that none can succeed is by the use of the general principles of the quantum theory, but it is profitable to consider a few further examples and show in detail how the attempts fail. We have seen that a microscope is no use, and so we try to make use of a method that does not require one. If, for example, we have a shutter with a very small hole in it, and have a source of electrons on one side, then if we find one on the other, we know it must have come from the hole, and so we can locate its position in that way. We must work out the experimental arrangements a little more carefully. The experiment might be done in this way. We have a pair of parallel plates ABC and FGH. Electrons start at rest from ABC and fall under the influence of a force

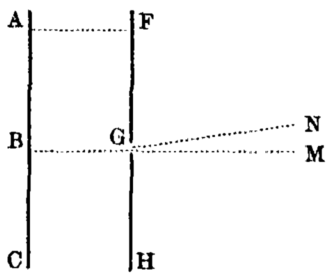


FIG. 1

towards FGH. They will move exactly in directions parallel to AF. The idea behind the experiment is a little more complicated than before because it is necessary to consider the different directions separately. When an electron has emerged from the hole at G, it thereby tells us what its position is as far as concerns the direction GF, but says nothing about its position in the direction GM. So our interest is in the velocity in the direction GF and we do not care what the component in the direction GM may be. Now to the left of G we know the electron's motion to be along BG, that is to say its component in the direction GF is zero. We seem to have conquered the uncertainty principle since we know the speed to be zero and the position is given as accurately as we please by taking the hole at G small enough. But we only know that the electron was on the line BG and not on the line AF because it emerges at G, and in emerging it will be diffracted, say along the line GN, and so will acquire a component of velocity transversely, and one which is uncertain in amount. Once again the mere fact of finding the position has introduced an unwanted velocity. Notice too that if the hole is rather large there is not much diffraction and so very little uncertainty in the velocity, but to counterbalance this advantage there is no very precise knowledge of the position; while, on the other hand, with a very small hole we can fix the position accurately, but pay for it by strong diffraction and so great uncertainty in the speed of the electron after it has emerged.

We will not yet confess defeat. It is true that the electron has been diffracted, but can we not measure through what angle it has turned? If we can do so we can conquer the uncertainty principle, not by avoiding the effect of the observing instrument, but just as successfully by measuring it. We might proceed for example as follows. The electron has altered its course in passing through G. A force of some kind must be necessary to produce this deflection, and this will react on the shutter and tend to push it in the opposite direction. If then we measure this reaction we can assert what path the electron has taken, and this is what we want to know. The simplest way of observing the reaction is to make the shutter free and very light, so that as the electron passes it will be set in motion. We adopt this method. But if the shutter is free, how do we know where the slit is at the moment the electron is passing? We have settled the question of the momentum satisfactorily, but in doing so have lost the position. We must try again, and devise a plan by which to know the position. We therefore send a beam of light through the hole and by watching this beam we can see where the hole is. Surely we now know both position and momentum at the same time. But no, we have forgotten something, for the light itself will behave in the same way as it did in the microscope; it will be diffracted at the hole and will itself start giving impulses to the shutter. There is no way of knowing whether the impulse we observe belongs to the electron or to the light, so that we have regained the measurement of the position, but have paid the price by once more losing the momentum.

It is not by any means easy always to detect the fallacy in experiments like this, but there always is something wrong. Each time we find the defect in our process, we must install some extra piece of apparatus to put it right, and the addition, in the course of overcoming the old difficulty, always introduces a new one. There is no escape from the uncertainty principle.

The uncertainty principle is essentially only concerned with the future; we can install instruments which will tell us as much about the past as we like. Suppose, for example, that we have two shutters, each provided with a very small hole, and a source of electrons to the left of both. The holes are usually blocked up, but for a very short space of time I first open the one in the left shutter, and at a definite time later I do the same for the one on the right. I look for electrons to the right of both shutters. If I see one, I can be quite certain that it went along the line between the holes and took a definite time in doing so; that is to say, I can know its position and speed

precisely. What the principle asserts is that this knowledge is no use in predicting what is going to happen later, for it gives no knowledge of how the electron will be diffracted on emerging from the second hole.

This must revolutionize our ideas about one of the most fundamental principles which have always been accepted in science, the principle of causality. We are accustomed to take it for granted that a *full* knowledge of the present would enable us confidently to predict the future. When we are defeated in our attempts at prophecy, we attribute it to ignorance, with the tacit assumption that with more knowledge of the present we could have done better. It never occurred to any one that the present is definitely unknowable; but we have just seen that the mere effort to know it can not help introducing new errors in the determination. It has been suggested that the new outlook will remove the well-known philosophical conflict between the doctrines of free will and determinism, and it has been welcomed by many for that reason. I would personally offer a most strenuous opposition to any such idea. The question is a philosophic one outside the region of thought of physics and I can not see that physical theory provides any new loophole. We can not say exactly what will happen to a single electron, but we can confidently estimate the probabilities. If an experiment is carried out with a thousand electrons, what was a probability for one becomes nearly a certainty; that is to say, we shall expect to have to repeat our experiment a great many times before we get a result departing far from the average. Physical theory confidently predicts that the millions of millions of electrons concerned in matter-in-bulk will behave even more regularly, and that to find a case of noticeable departure from the average we should have to wait for a period of time quite fantastically longer than the estimated age of the universe. How then does the uncertainty principle help to free us from the bonds of determinism?

SERIAL LITERATURE USED BY AMERICAN GEOLOGISTS

By Professor P. L. K. GROSS and Professor A. O. WOODFORD
POMONA COLLEGE

IN 1927, Gross and Gross[1] applied the method of statistical investigation in its simplest form to the problem of evaluation of the periodical literature of a science. They tabulated the references, to other periodicals, in a volume of the *Journal of the American Chemical Society,* and drew certain conclusions concerning the needs of college chemistry libraries. They expressed the hope that workers in other fields might make similar surveys. The interest among librarians and chemists was sufficient to show that the results were worth the labor expended. More recently, other studies have appeared, dealing with mathematics[2] and electrical engineering.[3]

A primary difficulty was encountered in sciences other than chemistry. The *Journal of the American Chemical Society* seems to be unique among scientific periodicals, in that a single volume contains more than 5,000 pages, about 700 articles, and about 5,000 citations to serial literature. It is also sufficiently well balanced in regard to the various branches of chemistry to assure a representative sample of the needs of the American chemist. In other sciences several source journals must be selected.[4]

The present investigation deals with the serial literature of geology, including mineralogy. Six American journals for 1929 were chosen, and the references tabulated. In Table I are listed these *source journals,* together with the total number of pages of the actual articles studied, the total number of citations in each journal, the number of references to books and to personal communications, and the net total, which represents the citations to serial literature. It is these last mentioned references which will be considered in further detail. The totals are probably slightly high, due to unintentional counting in single articles of repetitions of the same citation.

The net total of 3,574 references from six journals of geology (Table I) corresponds to a total of 2,165 from nine journals of mathematics, as reported by Allen,[5] and about 5,000 such references from a single volume of the *Journal of the American Chemical Society.* The contrast between chemistry and the other sciences is evident.

The count of references to books and to personal communications was made because it shows the relative importance of the various sources of information.

If one considers several source journals to be of equal importance, it is evident that there are at least three distinct methods of evaluation: first, an equal

[1] P. L. K. Gross and E. M. Gross, "College Libraries and Chemical Education," SCIENCE, 66: 385, 1927.

[2] Edward S. Allen, "Periodicals for Mathematicians," SCIENCE, 70: 592, 1929.

[3] J. K. McNeely and C. D. Crosno, "Periodicals for Electrical Engineers," SCIENCE, 72: 81, 1930.

[4] An investigation of the serial literature of physics, in progress here, suggests that the *Physical Review* is now so large and varied that it may prove adequate as a single source journal for the science.

[5] *Loc. cit.*

TABLE I

Name of source journal	Number of pages	Total number of references	References to books	Personal communications	Net total
*Am. J. Sci.**	860	898	91	33	774
Am. Mineral.	401	505	53	6	446
Bull. Am. Ass. Petroleum Geol.	959	588	36	33	519
Bull. Geol. Soc. Am.	528	916	158	11	747
Econ. Geol.	787	683	87	15	581
J. Geol.	746	594	57	30	507
Totals	4,281	4,184	482	128	3,574

* Insofar as possible the abbreviations used in this paper follow *Chemical Abstracts*, and may be found in its list of periodicals abstracted, published October 20, 1926, as Part 2, Vol. 20, No. 20. For the journals mentioned here which are not to be found in this list, the writers have chosen abbreviations the meaning of which, it is hoped, will be obvious. The usage of the *U. S. Geological Survey Bulletin* No. 746 (1922) is not followed because of the frequent use of initials, *e.g.*, *J. G.* for *Journal of Geology*. Incidentally the writers desire to protest against the common use in references of mere initials, such as *A.A.A.G.*, *A.A.A.S.*, and *A.A.P.G.* Still less satisfactory are partial or complete translations of foreign titles, such as *Proc. kön. Akad. Wettenschappen Amsterdam* or *Proc. Inter. Geol. Congress*. One common abbreviation, *Min. Mag.*, is ambiguous.

time period may be considered; second, an equal net total of references may be used; third, an equal number of pages of each source journal may be studied. After careful consideration of these three methods, the first was chosen, and complete volumes for 1929 were used with one major and two minor exceptions. These exceptions follow: (1) But eight numbers (May to December, both inclusive) of the *Bulletin of the American Association of Petroleum Geologists* were used. This was, in part, due to the fact that a single volume of this journal contains many more pages than any other source journal considered. (2) The first 1930 issue of the *Journal of Geology* was used instead of the Chamberlin memorial number of 1929, which was more nearly biographical than geological in character. (3) A few articles in the *American Journal of Science* were not included because they dealt with mathematics or pure chemistry. After the main study was completed an investigation was made (by means of weighting) of the other two methods and but few changes, all of little importance, were found. This was to be expected, as inspection of Table I will show that there are few large deviations from equal numbers of references or equal numbers of pages in the source journals as they were used.

The choice of source journals was limited to American publications in order to show the serial literature actually used by American geologists. Excepting paleontology, the various geological sciences are more or less adequately represented. Some paleontological papers are present in the source journals used, but the synonymies of taxonomic descriptions are not included. The *Journal of Paleontology* was not used as a source because its 1929 citations do not begin to cover the varied library requirements of American paleontologists.

Table II*a* shows the results of the tabulation of the citations to the twenty-two journals most frequently mentioned. The distribution of references is

TABLE II*a*

Name of journal cited	Net total citations	1925–1929	1920–1924	1915–1919	1910–1914	1905–1909	1900–1904	1832–1899	No. of libraries*
Am. J. Sci.	240	59	40	39	36	18	12	36	97
U. S. Geol. Surv. Bull.	234	26	60	40	42	38	13	15	.....
J. Geol.	207	62	41	29	25	23	20	7	.....
Bull. Geol. Soc. Am.	187	65	51	18	15	10	16	12	77
U. S. Geol. Surv. Prof. Papers	144	31	28	30	21	23	11	.....	.....
Econ. Geol.	143	64	40	21	11	7	.....	.....	.....
Bull. Am. Ass. Petroleum Geol.	142	119	20	3	.....	.....	.....	.....	44
Z. Krist.	76	17	23	6	5	4	7	14	27
Am. Mineral.	65	49	15	1	.....	.....	.....	.....	49
U. S. Geol. Surv. Water Supply Papers	51	10	4	4	10	18	4	1	.....
Science	47	17	1	3	8	15	1	2	115
Can. Geol. Surv. Mem.	46	13	8	14	10	1	.....	.....	.....
Neues Jahrb. Mineral. Geol.	46	16	5	5	5	4	4	7	39
U. S. Geol. Surv. Geol. Atlas	45	4	4	1	3	17	7	9	.....
Trans. Am. Inst. Min. Met. Eng.	41	13	6	7	4	1	3	7	56
Compt. rend.	40	3	6	11	4	8	2	11	80
Quart. J. Geol. Soc.	39	11	1	0	3	1	0	23	59
U. S. Geol. Surv. Monographs	37	0	0	2	8	1	6	20	.....
Eng. Min. J.	34	22	5	0	4	1	1	1	76
J. Wash. Acad. Sci.	33	16	6	9	2	.....	.....	.....	58
U. S. Geol. Surv. Ann. Repts.	29	.....	.....	.....	.....	.....	11	18	.....
Geol. Mag.	28	5	8	2	3	5	7	3	56

* The data in this column were obtained from the "Union List of Serials" (1,588 pages, H. W. Wilson and Company, New York, 1927), and give the number of libraries which reported current accession of the serial indicated. The "Union List" does not include government publications, and does not give exact data for some common journals. Two hundred and twenty-five general and special libraries contributed information.

by five-year periods. It appears that the leading serials hold their own whether long or short periods are considered. The large percentages of the references to the *Bulletin of the American Association of Petroleum Geologists* and to the *American Mineralogist* which fall in the last five-year period are indicative of the growing importance of these recently established journals.

The totals for the next thirty-one ranking journals are given in Table II*b*. The writers do not mean to give the impression that the dividing point between Tables II*a* and II*b* has significance. They feel, however, that the distribution into short time periods is without meaning when but few citations occur. Toward the end of Table II*b* will be found journals with so few references that their inclusion on a strict statistical basis would not be justified.

TABLE II*b*

Name of journal cited	Number of citations	Number of libraries*
N. Y. State Mus. Bull.	27	66
Z. Gletscherkunde	26	20
Geol. Fören. Förh. (Stockholm)	25	18
Univ. Calif. Pub. Bull. Dept. Geol. Sci.	25	52
Univ. Tex. Bull.	24	......
Carnegie Inst. Pub.	23	......
J. Am. Chem. Soc.	23	102
Centr. Mineral. Geol.	21	29
Am. Geol.	20	......
Smithsonian Inst., Miscellaneous Collections	20	......
Petermanns Mitt.	19	39
Z. deut. Geol. Ges.	19	29
Can. Geol. Surv. Summary Rept.	18	......
Geogr. Rev.	18	......
Z. prakt. Geol.	18	34
Bull. comm. géol. Finlande	17	......
Mineral. Mag.	17	32
Ontario Bur. Mines Bull.	17	......
Pan-American Geol.	17	38
Skrifter Norske Videnskaps-Akad. Oslo	17	22
Bull. Mus. Comp. Zool., Harvard	16	34
Geogr. J.	16	......
Bull. soc. franc. minéral.	15	24
Geografiska Ann. (Stockholm)	15	12
Okla. Geol. Surv. Bull.	15	......
J. Chem. Soc.	14	80
Oil and Gas J.	14	29
Proc. Nat. Acad. Sci.	14	......
Trans. Roy. Soc. Can.	14	74
Z. anorg. Chem.	13	63
Z. Ges. Erdkunde (Berlin)	13	24

* See note to Table II*a*.

Many well-known general and geological serials are missing from Tables II*a* and II*b*. Since low standings might be peculiar to the 1929 files, citations to certain of these publications were sought in the 1927 and 1928 volumes of the source journals, with the results shown in Table III.

TABLE III

Name of journal	Citations in 1929	Citations in 1928	Citations in 1927	Number of libraries*
Bull. soc. géol. France	9	5	5	83
Bull. Seism. Soc. Am.	4	7	2	49
Bull. Geol. Inst. Univ. Upsala	5	7	7	34
Compt. rend. Congr. géol. intern.	9	1	8	.....
Geol. Zentr. (abstract journal)	8	1	1	40
Geol. Rundschau	5	1	5	21
Jahrb. preuss. geol. Landesanst.	8	1	2	9
Jahrb. geol. Bundesanst., Wien	2	1	3	20
Proc. Roy. Soc. London, (A)	6	6	5	70
Sitsb. preuss. Akad. Wiss., phys.-math. Kl.	9	5	3	33
Sitsb. Akad. Wiss., Wien	8	0	11	25
Trans. Roy. Soc. Edinburgh	5	11	7	47
Tschermaks mineral. petrog. Mitt.	11	7	5	23
Z. Vulkanologie	6	0	2	24

* See note, Table II*a*.

In no case is there a rise to the horizon of Table II*b*.

While the data for Table III were being obtained, it was noticed that most of the serials of Table II*b* were often mentioned in 1927 and 1928. The exceptions noted were the *Zeitschrift für Gletscherkunde* and the *Geografiska Annaler*. The high positions of these two journals in 1929 were due to a large number of glacial papers published in our source journals during that year.

The last column of Table III indicates that the serials of this table are nearly as common in American libraries as are the series listed in Tables II*a* and II*b*. In fact, half the journals in Table III have a wider distribution among the libraries considered than does the *Zeitschrift für Kristallographie,* the first foreign serial of Table II*a*. In this connection, it may be suggested that the importance of a given file for geologists is not directly proportional to the number of libraries possessing it. On the contrary, it may be argued that the inverse is more nearly true for journals to which there are approximately equal numbers of citations. For instance, by this test the *Geologiska Föreningens i Stockholm Förhandlingar* are more important than the *University of California Publications Bulletin of the Department of Geological Sciences,* as the position of the former was attained

in spite of relative inaccessibility to American workers (see Table II*b*).

Table IV summarizes the data concerning the frequency of references to the various serials. The 480 publications to which citations occurred were found to be distributed among thirty countries (counting British dominions and colonies) and fifteen different languages.

TABLE IV

	No. of serials	No. of references	Per cent. of references
Serials included in Table II*a*	22	1,954	54.7
Serials included in Table II*b*	31	570	15.9
Serials cited 7 to 12 times	36	303	8.5
Serials cited 4 to 6 times	52	246	6.9
Serials cited 3 times	48	144	4.0
Serials cited 2 times	66	132	3.7
Serials cited 1 time	225	225	6.3
Totals	480	3,574	100.0

In choosing source journals the writers limited themselves to national American periodicals. As one test of the selections Table V shows the effect of excluding from the citations to the source journals all self-references, that is, references to papers published in the same journal.

TABLE V

Name of source journal	Table II*a*, totals	Self-references	Other references
Am. J. Sci.	240	94	146
J. Geol.	207	70	137
Bull. Geol. Soc. Am.	187	59	128
Econ. Geol.	143	115	28
Bull. Am. Ass. Petroleum Geol.	142	118	24
Am. Mineral.	65	44	21

It will be seen from the last column of Table V that there is no change in the relative rank of the source journals. There does appear, however, a striking difference between the first three journals and the second three. Although other explanations are possible, it is believed that this is due to the unique positions of the latter in specialized fields. Such an explanation strengthens the case for including the last three serials as source journals.

Government publications have an important place in geological literature. This is evident from the data of Tables II*a* and II*b*. Fifteen per cent. of the total of 3,574 references are to the various series of the United States Geological Survey. It should prove interesting, therefore, to compare the relative importance to American geologists of their own and other governmental publications. These data are summarized in Table VI and show at once three things: first, United States and Canadian governmental reports are of prime importance; second, the small number of Canadian "Other references" suggests that the journals of the United States serve both this country and Canada; third, foreign governmental publications are but rarely used by American geologists.

TABLE VI

Country	References to governmental publications			Other references
	National	Provincial and state*	Total	
United States	607	299	906	1,504**
Canada	97	19	116	23
Gt. Britain and poss. (except Canada)	6	11	17	244
Germany and Aus.	2	17	19	448
France	1	1	2	71

* Including state universities.
** Of these, 984 are to the six source journals.

Many of the domestic references are to areal surveys, and the corresponding publications of other governments are vastly less essential to the North American worker. However, the rarity of references to foreign surveys suggested an analysis of the total number of foreign references, to determine in what portions of the field of geology American workers look abroad. To this end, the citations in individual source journals were tabulated. The differences between the sources were so striking that the writers decided to include the data for 1928 and part of 1930 (for this tabulation only), as checks upon 1929. These results are shown in Table VII.

It appears that journals which include mineralogical papers contain more foreign references than do the more strictly geological periodicals. Further analysis is difficult, and differences seem to be largely idiosyncrasies of individual authors. An example of this variability is found in the 1929 *Journal of Geology,* where all of the references to foreign books or periodicals occur in 17 of the 50 papers. However, glacial geologists seem rather consistently to use foreign data, as shown by the frequent European references in four of the seven glacial papers in this volume of the *Journal of Geology,* and also by the obviously elevating effect of a glacial symposium upon the foreign percentage for 1929 of the *Bulletin of the Geological Society of America* (Table VII).

TABLE VII

Name of source journal	Per cent. of references to serials published outside the United States and Canada			
	1928	1929	1930*	1928–1930
Am. J. Sci.	31.1	30.5	29.3	30.2
Am. Mineral.	36.0	55.6	35.8	42.7
Bull. Am. Ass. Petroleum Geol.	18.1	10.6	10.5	12.2
Bull. Geol. Soc. Am.	17.1	40.0	19.3	28.4
Econ. Geol	23.9	17.4	18.4	20.0
J. Geol.	14.8	10.9	9.9	12.0

* All 1930 issues of the source journals available here on November 24, 1930, were considered, *i.e.*, *Am. J. Sci.*, January to November; *Am. Mineral.*, Nos. 1–11; *Bull. Am. Ass. Petroleum Geol.*, Nos. 1–11; *Bull. Geol. Soc. Am.*, Nos. 1–2; *Econ. Geol.*, Nos. 1–7 and Suppl. to No. 3; *J. Geol.*, Nos. 1–7.

Finally, Table VIII presents the 1,015 foreign references (Canada again considered as domestic, as justified above) classified according to language. Danish, Norwegian and Swedish are grouped together as Scandinavian. The great relative importance of German is apparent. French suffers, perhaps, from the scarcity of paleontological references in the sources

TABLE VIII

Language	Foreign references	
	Number	Per cent.
German	486	47.9
English	262	25.8
Scandinavian	87	8.6
French	84	8.3
All others	96	9.4
Totals	1,015	100.0

considered, but probably gains in number of titles because of the brevity of the contributions (forty in number) to the principal French periodical, *Comptes rendus*.

OBITUARY

MEMORIALS

The significance of the work of John Bartram was commemorated by representatives of leading botanic and horticultural associations in this country and in England at the celebration of the two hundredth anniversary of the founding of Bartram's Garden, the first botanic garden in the American colonies. The observance was held at the Academy of Natural Sciences in Philadelphia on June 5 and 6, also at the Bartram Garden, overlooking the Schuylkill River, by the John Bartram Association, the American Philosophical Society, the Pennsylvania Horticultural Society and the Academy of Natural Sciences. Among the speakers were Dr. Rodney Howard True, professor of botany at the University of Pennsylvania, and Dr. John Hendley Barnhart, bibliographer of the New York Botanic Garden. An address by Dr. Witmer Stone, vice-president of the Academy of Natural Sciences of Philadelphia, was read in his absence.

The British Medical Journal reports that a fund is being raised to establish a permanent memorial to Dr. Hughlings Jackson. Among those who are taking action in the matter are many old friends and pupils who revered and loved Jackson, and who recognize to what an extent the preeminent position of British neurology in the medical world is due to his work and influence. He was among the great leaders of modern neurology, and it is much to be desired that the inspiration that he gave to so many in his lifetime should be kept fresh, and still serve as a stimulus to a younger generation who knew him not. It is hoped to raise an amount sufficient to provide a permanent endowment for the Hughlings Jackson Lecture, given every third year before the section of neurology of the Royal Society of Medicine. Several generous promises of support to such a fund have already been received, but the signatories of this letter feel that an opportunity to subscribe should be given to many who can only be reached through the publicity of the press, and who would certainly wish to show their appreciation of the position which Hughlings Jackson holds in the history of modern medicine. Dr. Wilfred Harris, of 56, Wimpole Street, London, W.1, has consented to act as treasurer of the fund, and subscriptions should be sent to him, marked "Hughlings Jackson Memorial Fund."

RECENT DEATHS

Dr. Franklin Henry Giddings, professor emeritus of sociology at Columbia University, died on June 11. He was seventy-six years old.

Dr. Joseph H. Hathaway, assistant professor of anatomy at the University of Michigan, died on June 12, at the age of fifty-two years.

Miss Emily Howson, professor of astronomy at Agnes Scott College, Decatur, Illinois, died on June 6th.

THE death is announced of M. Raoul Gautier, honorary director of the Geneva Observatory.

PROFESSOR G. B. FROSTERUS, director of the Institute for Soil Science, Helsinki, died on March 1 at the age of sixty-five years. Dr. Frosterus took part in the development of soil science in Finland and was an active member of the International Society of Soil Science.

THE death at the age of ninety-two years is announced of Professor Welhelm Franz Exner. Dr. Exner was for some time professor at the College of Agriculture of the University of Vienna and later professor of mechanical technology and engineering.

Nature reports the death of Dr. Rudolf Marloth, who was president of the South African Association for the Advancement of Science in 1914 and author of works on the flora of South Africa, and of Dr. Alwin Berger, an authority on succulent plants and cacti, who contributed a monograph on the Crassulaceae to Engler-Prantl's "Natürliche Pflanzenfamilien."

SCIENTIFIC EVENTS

BOTANICAL RESEARCH STATIONS IN AFRICA

SIR ARTHUR HILL, director of the Royal Botanic Gardens, Kew, recently addressed the Dominions and Colonies Section of the Royal Society of Arts on the scientific research work he had seen during his recent tour in South and East Africa.

According to an abstract in the London *Times* the lecturer described the principal centers of research work that he visited and singled out the National Botanic Garden at Kirstenbosch as one of the most remarkable. Here, he said, with the unique and magnificent setting of Table Mountain and the groves of the beautiful Silver Tree (*Leucadendron argenteum*), there was being built up a garden which, with proper care and attention in the way of sufficient funds for maintenance and development, should be one of the great botanic gardens of the world. Kirstenbosch was bought by Cecil Rhodes, in 1895, as part of his far-sighted scheme for preserving the eastern slopes of Table Mountain and Devil's Peak as a National Park, and in 1913, thanks to the efforts of the late Professor Harold Pearson and Sir Lionel Phillips, a portion of the estate was set aside by government for the establishment of a National Botanic Garden.

It was very much to be hoped that no pains or money would be spared in order to carry out to the full the vision of those two benefactors to botany in South Africa, so that the garden might be fully developed; also that the slopes of the mountain might be adequately preserved both from the depredations of forest fires and from the incursions of exotic trees. Thus only could we hope to see Rhodes's vision of a great National Park on Table Mountain and Pearson's conception of a South African National Garden properly honored by memorials of supreme interest and value to the whole world.

Referring to the East African Agricultural Research Station at Amani, in the East Usambara Mountains, Tanganyika Territory, Sir Arthur said that the question of soils was also one of great importance to all the East African Territories and a Soil Museum was being built up at Amani, which in course of time should be as useful as a herbarium with its botanical specimens. Those soil samples would be of particular value in ascertaining the physical and chemical properties of those East African soils known to be subject to serious erosion, which was so important a problem in the tropics.

THE REFORESTATION PROGRAM

FOREST planting by all agencies in the United States amounted last year to 138,970 acres, a gain of 24 per cent. over 1929, according to completed reports from 43 states and territories made public on June 6 by the Forest Service of the Department of Agriculture. Last year's planting brought the cumulative record for all lands reforested to date in the United States to 1,798,048 acres. Federal, state, municipal and private plantings all made substantial gains despite drought and adverse economic conditions.

Other than the federal and state governments, 19,161 agencies and individuals participated in forest planting last year, which set the new record for acreage reforested. Of the more than 17,000 individuals about four fifths were farmers.

Forest Service plantings in the National Forests amounted to 21,678 acres, 19 per cent. more than the year preceding. Forest Service plantings are planned on a still larger scale this year, and spring planting has been active in several National Forests.

State forestry department plantings last year amounted to 41,038 acres, a gain of 30 per cent. over 1929. Plantings by municipalities aggregated 9,214 acres, an increase of 55 per cent. Industrial organizations planted 30,230 acres, a gain of 20 per cent., and organizations of other types, with 2,518 acres planted, gained 66 per cent. Schools and colleges put out 825 acres of trees, 53 per cent. more than the

year before. Individual plantings jumped from 28,-475 to 33,467 acres, a gain of 17 per cent.

Last year's totals showed important progress and interest in renewing forest resources and putting idle lands to growing timber crops, although planting has never yet kept pace with losses through wasteful cutting, forest fires and erosion.

Michigan led all the states in acreage reforested for 1930, with a grand total of 38,302 acres planted by all public and private agencies. Of this area, the Forest Service planted 8,452 acres and the state 26,-617 acres.

Forest planting in New York by various state, municipal and private agencies reached 24,250 acres. Pennsylvania planted 18,048 acres to public and private forest.

Planting in Delaware, Maryland and New Jersey aggregated 1,672 acres. New England reports show a total of 11,614 acres planted. The South Atlantic States planted 5,556 acres, Georgia leading with 2,542. Gulf States set out 7,869 acres, Louisiana's share being 6,556.

In Ohio, private and public agencies planted 2,633 acres, largely farm woodlands. Beginnings were made in several Central States with reforestation used especially as a check to erosion of farm lands. Part of Wisconsin's plantings of 6,086 acres were for watershed and farm.

THE GUATEMALA EXPEDITION

Despite a severe rainy season, tangled jungle trails and the illness of one of the party, the University of Michigan expedition into the interior of Guatemala has returned with an unusually large number of important specimens. Members of the party included Professor Harley H. Bartlett, botanist; Dr. Josselyn Van Tyne, ornithologist, and Dr. Adolph Murie, mammalogist, they having undertaken the biological phase of a broad survey by the Carnegie Institution.

Meeting with Carnegie archeologists at Belize, British Honduras, on January 26, the party planned to proceed at once to the old Maya city of Uaxactun, but were turned back by news that heavy winter rains had made jungle trails impassable. While waiting for the trails to become passable, the "Pine Ridge" area was visited. This involved a trip of three days and nights of travel in small boats up a shallow winding river. Sharply demarked from surrounding jungle, this "pine ridge" appears much as if a strip of northern Michigan's open pine woods had been transplanted in the tropics.

Finally the jungle trails were reported "passable for mules," and the party returned to their base at El Cayo. But "passable for mules" proved almost impassable for men, and the sixty-five miles inland required four days of the hardest kind of travel and the simple "bush" camp at Uaxactun looked luxurious when finally reached.

In these jungles 1,900 years ago the Mayas began the building of their great stone cities. They have now become a tangled jungle almost unknown to white men and specimens, exceptional both in quantity and in quality, were secured.

Due to the large amount of material and limited accommodations, the party broke up, Professor Bartlett going out first with his extensive botanical collection. On arriving at El Cayo, the mule train was to unload and return for Drs. Van Tyne and Murie, before the rains should set in making travel impossible. Unfortunately at this point Dr. Van Tyne was taken with a sudden and severe attack of jungle fever. Dr. Murie, however, and Mr. Monroe Amsden, of the Carnegie party, finally brought him and all the collections safely back to civilization.

The classification of the specimens will be carried out at the museum. It is probable that a second visit to this region will be made next year.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

At its meeting in May the National Research Council's Committee on Grants-in-Aid made grants for the support of research as follows:

To S. J. Barnett, professor of physics, University of California at Los Angeles, magnetization by rotary fields; Harry E. Farnsworth, associate professor of physics, Brown University, electron diffraction and refraction by metal crystals; R. C. Gibbs, chairman of the committee on ruled gratings of the American Physical Society, professor of physics, Cornell University, improvement of facilities for the manufacture of diffraction gratings; Ernest O. Lawrence, professor of physics, University of California at Berkeley, the production of high velocity hydrogen ions without the use of high voltages; Arthur E. Ruark, professor of physics, University of Pittsburgh, measurement of wave-lengths and line-widths in the spectra of Gamma rays; Karl S. Van Dyke, professor of physics, Wesleyan University, the piezo-electric effect in quartz and Rochelle salt.

Wilber E. Harvey, instructor, Lehigh University, the combined effects of corrosion and fatigue upon welds.

Frank T. Gucker, Jr., assistant professor of chemistry, Northwestern University, the thermo-chemistry of solutions and the dielectric constant of the solvent.

M. R. Campbell, principal geologist, U. S. Geological Survey, the gravel deposits of the Piedmont Plateau and Atlantic coastal plain north of Virginia; C. H. Crickmay, assistant professor of geology, University of Illinois, the Jurassic deposits of Mt. Jura, California; Richard M. Field, associate professor of geology, Princeton University, the stability of the Bahama

Islands in relation to their origin, migration and alteration of the sediments which mantle their surfaces; Edwin T. Hodge, professor of geology, University of Oregon, completion of geological study of Mt. Hood region in Oregon; Frank O. Melton, associate professor of geology, University of Oklahoma, tectonics of the continental interior of North America in relation to the Appalachian orogeny; Ellen C. Semple, Clark University, preparation for publication of "Geographic Influences in the History of the Mediterranean Region."

T. Hume Bissonnette, professor of biology, Trinity College, modification and control of the sexual cycle in the European starling; George O. Burr, associate professor of botany, University of Minnesota, the rôle of fatty acids in animal metabolism; Cleveland S. Simkins, associate professor of anatomy and embryology, University of Tennessee Medical School, the human ovary from birth to sexual maturity.

Ralph E. Cleland, associate professor of biology, Goucher College, cytological and gentical studies of *Oenothera;* George R. La Rue, professor of zoology, University of Michigan, distribution of the lung fluke, *Paragonimus,* in America; Charles L. Parmenter, associate professor of zoology, University of Pennsylvania, chromosome formation in parthenogenetically produced frogs; James T. Penney, associate professor of biology, University of South Carolina, cell behavior in fresh-water sponges; William Rowan, associate professor of zoology, University of Alberta, bird migration from the view-point of animal behavior; Carl G. Vinson, professor of horticulture, University of Missouri, the virus diseases of plants.

Franklin Fearing, associate professor of psychology, Northwestern University, the functions of the non-acoustic portion of the labyrinth in pigeons; Frederick S. Hulse, research assistant in anthropology, Bishop Museum, Honolulu (at present at the Peabody Museum, Harvard University), race mixture between Spanish, Indian and Negro stocks; John A. McGeoch, professor of psychology, University of Missouri, the influence of the time interval and of the point of interpolation upon degree of retroactive inhibition; Jessie W. Murray, acting director, Tioga Point Museum, investigation of aboriginal Indian sites near Athens, Pennsylvania.

VERNON KELLOGG
Permanent Secretary,
National Research Council

SCIENTIFIC NOTES AND NEWS

DR. LELAND O. HOWARD, until his retirement in 1927 chief of the Bureau of Entomology of the U. S. Department of Agriculture, Washington, D. C., has been awarded the 1931 Capper Gold Medal and the sum of $5,000 for distinguished service to American agriculture. Last year's award was given to Professor Stephen Moulton Babcock, professor emeritus of agricultural chemistry at the University of Wisconsin.

THE University of Paris conferred on June 13 honorary degrees on Dr. Henry Fairfield Osborn, director of the American Museum of Natural History, New York, and on Dr. Walter B. Cannon, professor of physiology in the Harvard Medical School.

THE honorary doctorate of science was conferred on Dr. Howard McClenahan, secretary of the Franklin Institute, formerly professor of physics and dean of the college at Princeton University, at the recent commencement exercises of the University of Pennsylvania.

DR. KARL LANDSTEINER, a member of the Rockefeller Institute for Medical Research, New York, was recently elected a member of the Royal Danish Academy of Sciences in Copenhagen, in the class of the natural sciences and mathematics.

MME. CURIE was recently appointed an honorary member of the Sociedad Española de Fisica y Quimica in a ceremony at the University of Madrid, where she delivered lectures on radioactivity. Mme. Curie went to Spain on the invitation of several national medical and scientific societies.

DR. HANS HORST, professor of pharmacology at the University of Vienna, has been elected a foreign member of the Royal Swedish Academy of Sciences.

SIR OLIVER LODGE celebrated his eightieth birthday on June 12.

THE American College of Radiology on June 10 awarded its gold medal to Dr. Charles C. Lauritsen, professor of physics at the California Institute of Technology, Pasadena, in recognition of his work resulting in "the first practical high voltage tube operating daily for experimental research."

M. PAUL PELSENEER was recently elected a correspondent of the Paris Academy of Sciences in the section of anatomy and zoology in the place of the late M. A. Brachet.

AT the Philadelphia meeting of the American Medical Association gold medals were awarded to Dr. Jacob Furth, of the Henry Phipps Institute of the University of Pennsylvania, for experiments demonstrating that leukemia can be transmitted by a filterable virus, and to Drs. J. Parsons Schaeffer and Warren B. Davis, of Jefferson Medical College, Philadelphia, for anatomical researches on the nasal sinuses. Silver medals were awarded to Drs. Harrison S. Martland, A. V. St. George, Alexander O.

Gettler and Ralph H. Mueller for their detailed presentation of the subject of radium poisoning and to Dr. Bedford Shelmire, of Baylor University School of Medicine, and Dr. W. E. Dove, of the U. S. Bureau of Entomology, for original work on the spread of typhus fever by rat mite.

THE honorary degree of doctor of science was awarded to Admiral Richard E. Byrd and Professor Laurence McKinley Gould, of the University of Michigan, leaders of the Byrd Antarctic Expedition, by the Polytechnic Institute of Brooklyn at the seventy-sixth annual commencement exercises on June 17. Professor Gould delivered the commencement address on "Antarctic Research and the Byrd Expedition." Scientific exploration as indicated by the Byrd expedition will be the general subject at the dinner of the Corporation of the Polytechnic Institute on the evening of June 22 at the University Club of New York, where explorers will gather in informal discussion of the value of world travel and research. On this occasion a review of earlier Arctic explorations will be presented by Major Anthony Fiala to be followed by a study of the recent Vincent Astor Expedition to the Galapagos Islands, by Dr. Charles H. Townsend, director of the New York City Aquarium. Professor Laurence McKinley Gould, of the University of Michigan, will present a paper on the scientific aspects of the Byrd expedition, while Dr. Walter Granger, curator of fossil mammals at the American Museum of Natural History and scientific head of the expedition to Mongolia of the museum, will present a review of the results of that exploration.

THE prize of $250 offered by the Scientific Apparatus Makers of America for the best paper on instruments appearing in *The Review of Scientific Instruments* during the calendar year 1930 has been awarded to Mr. K. C. D. Hickman and Mr. C. R. Sanford, of the Eastman Kodak Research Laboratory, Rochester, for their joint paper entitled "A Study in Condensation Pumps," which appeared in the March issue of the *Review*. The committee made special mention of the paper by Mr. J. D. Hardy entitled "A Theoretical and Experimental Study of the Resonance Radiometer," which appeared in August and also of the paper by Mr. P. H. Carr entitled "A New Method of Recording Electrons," which appeared in December. The committee of award consisted of Professor J. R. Collins, Cornell University, *chairman;* Professor H. W. Webb, Columbia University, and Dr. H. W. Russell, of the Battelle Memorial Institute.

AT the Massachusetts Institute of Technology, Professor Erwin H. Schell has been appointed head of the department of business and engineering administration, and Professor Charles F. Taylor head of the department of aeronautical engineering. Dr. Louis J. Bircher, of Vanderbilt University, will be visiting professor of chemistry.

DR. PAUL KIRKPATRICK, professor of physics at the University of Hawaii, will be acting associate professor of physics at Stanford University during the academic year 1931–32. His place at the University of Hawaii will be taken by Dr. Harry Kirkpatrick, who, with Dr. J. W. M. Dumond, recently completed an investigation of the scattering of x-rays at the California Institute of Technology. Dr. Willard H. Eller will be in charge of the department of physics at the University of Hawaii while Dr. Kirkpatrick is on leave.

DR. A. E. NAISCH, lecturer in medicine at the University of Sheffield, has been promoted to the chair of medicine.

DR. AND MRS. LEWELLYS F. BARKER, of Baltimore, leave in June to spend the summer in Switzerland.

PROFESSOR AND MRS. COCKERELL, of the University of Colorado, sail on June 20 to England, and go thence to Africa, expecting to visit Benguella, Katanga, Lake Tanganyika, Rhodesia, the Cape Province, etc., returning to Colorado at the end of the year. The African expedition will include Miss Alice Mackie and Mr. and Mrs. J. Ogilvie.

DEAN F. B. MUMFORD, of the College of Agriculture of the University of Missouri, has been granted leave of absence until January 1. He plans to spend several months in Europe.

PROFESSOR J. N. LECONTE, of the department of mechanical engineering of the University of California, has been granted a year's sabbatical leave to visit hydraulic laboratories and installations in France and Germany.

THE Medical Fellowship Board of the National Research Council, of which Dr. G. Carl Huber, dean of the Graduate School of the University of Michigan, is the chairman, has made the following appointments of fellows in medicine for the year 1931–1932: Evelyn M. Anderson, Broda O. Barnes, Chandler McC. Brooks, Walter D. Claus, George Lyman Duff, Knox H. Finley, John H. Hanks, Carl M. Johnson, Peter K. Knoefel, Donald McEachern, Robert A. Moore, Harold S. Olcovich and Samuel R. M. Reynolds. The next meeting of the Medical Fellowship Board will be held on September 19, and applications to be considered at that time should be filed on or before August 15.

PROFESSOR WILLIAM E. RITTER, of the University of California, left Berkeley for London on May 23,

where on invitation from the president and executive committee of the Second International Congress of the History of Science and Technology he will participate in the London meeting of the congress from June 29 to July 3. Dr. Ritter will discuss the bearings of the Aristotelian teachings on the historical and contemporary inter-relationship of the physical and biological sciences.

DR. JOHN R. MURLIN, professor of physiology and director of the department of vital economics of the University of Rochester, gave the annual address before the Alpha chapter of Sigma Xi at Cornell University on May 15. His subject was "Modern Aspects of Vitalism."

AT the recent Philadelphia meeting of the American Medical Association, the Billings lecture, named for Dr. Frank Billings, was delivered before the section on medicine by Dr. Henry A. Christian, of the Harvard University Medical School, on the classification of different types of Bright's disease.

DR. HARVEY CUSHING, Moseley professor of surgery at Harvard University, delivered on June 11 the annual discourse at the one hundred and fiftieth anniversary convention of the Massachusetts Medical Society.

PROFESSOR HEBER D. CURTIS, director of the University of Michigan Observatory, gave the address at the dedication on June 3 of the new astronomical observatory at Wittenberg College, Ohio.

THE Ontario Radium Commission is visiting the large cities of the United States, making a study of the methods used in the treatment of cancer. Members of the commission include the Honorable John M. Robb, Minister of Health for Ontario; the Reverend H. J. Cody, chairman of the commission and chairman of the Board of Governors of the University of Ontario; Dr. Herbert L. Lombard, director of the division of adult hygiene, Massachusetts Department of Public Health; Dr. W. T. Connell, professor of medicine at Queen's University, and Dr. J. W. S. McCullough, chief inspector of health for Ontario. On June 26 members of the commission will leave for Europe. They will study facilities for treating cancer in London and other medical centers. Following a tour of Europe they will return to Ontario and will submit a report to the Ontario Legislature.

THE thirteenth annual meeting of the American Society of Mammalogists was held at the Academy of Natural Sciences of Philadelphia from May 12 to 15. Thirty papers on various phases of mammalogy were presented. The annual election of officers resulted as follows: *President,* Marcus W. Lyon, Jr.; *Vice-presidents,* T. S. Palmer, H. E. Anthony; *Recording Secretary,* H. H. Lane; *Corresponding Secretary,* Francis Harper; *Treasurer,* Mrs. Viola S. Snyder; *Directors,* class of 1931–1933, Joseph Grinnell, Remington Kellogg, A. Brazier Howell, W. E. Saunders, Wharton Huber; *Director,* to fill vacancy in class of 1930–1932, Lee R. Dice. Edward A. Preble continues as chairman of the editorial board in charge of the *Journal of Mammalogy.* The total membership of the society is now 1,017. The next annual meeting will be held at the U. S. National Museum in Washington.

A CONFERENCE of Connecticut and Rhode Island investigators in the chemistry and physiology of plants was held on June 5 and 6 in the laboratories of Yale University and of the Connecticut Agricultural Experiment Station. The first session was held at the Experiment Station, where the address of welcome was delivered by Director William L. Slate. The members inspected the experimental work of the various departments of the station, as well as the New Haven Branch of the United States Office of Forest Pathology, and the Marsh Botanical Gardens and Osborn Botanical Laboratory of Yale University. A dinner was given at the Yale Faculty Club and at 8:00 o'clock the conference reconvened in Sage Hall. Professor Andrew Keogh, Yale University librarian, welcomed the members to Yale. Director-Emeritus Russell H. Chittenden spoke on "Plant Sciences in Sheffield Scientific School." Plant science research in the Yale School of Forestry was described by Professor James W. Toumey. Dr. Treat B. Johnson, Sterling professor of chemistry, spoke on "The Need for Cooperation in Biochemical Research." Saturday morning was given to the presentation of some twenty-six research papers at the Osborn Botanical Laboratory.

THE eastern section of the Botanical Society of America will hold its biannual summer meeting at the Pennsylvania State College from June 16 to 19. The program for the four days includes a number of field trips.

THE first permanent exhibition in New York of exact scale models illustrating minutely the development of marine, highway and railroad transportation was opened to the public on May 25 at the Museum of Science and Industry, 220 East Forty-second Street, by Mr. Frederic B. Pratt, president. The exhibits include an arrangement of marine, railroad and automobile engines, and in the highway division there is a series of mechanical sets which may be put in motion to reveal the workings of brakes, axles, springs, gears and spark plugs. The exhibition, a part of a projected series which will ultimately portray the significant steps in the major fields of man's

material evolution, was arranged under the direction of Dr. Charles R. Richards, authority on industrial museums, assisted by Carlos de Zafra, of the engineering faculty of New York University; Charles E. Duryea, co-inventor of the Duryea automobile, and Henry O. Havemeyer, Jr.

THE Rush Rhees Library of the University of Rochester has been given a complete collection of the first editions of all the works of Charles Darwin, including a copy of the first printing of the first edition of the "Origin of Species." It is said that there is no similar collection in the United States.

THE Rockefeller Foundation has granted $30,000 to Iowa State College, to be used for research in biological sciences and related branches of physics and chemistry. The fund is to be paid during the next five years.

ARRANGEMENTS for cooperation between the Hebrew University of Jerusalem and the Field Museum, Chicago, were completed during a visit to the museum by Dr. Julius Magnes, president of the university, on May 8. Dr. Magnes consulted with members of the scientific staff, and formulated plans for exchange of specimens and publications between the two institutions.

LECTURES are announced at the New York Botanical Garden at 4 o'clock in the afternoons as follows: June 6, "John Bartram, American Quaker and Botanist to the King," Dr. John Hendley Barnhart, bibliographer. June 13, "Rice, the Greatest Food Plant in the World," Dr. H. A. Gleason, curator. June 20, "Vegetation of the Philippines," Dr. Elmer D. Merrill, director-in-chief. June 27, "Roses," Mr. Kenneth R. Boynton, head gardener. July 11, "Daylilies," Dr. A. B. Stout, director of laboratories. July 18, "Diatoms, Microscopic Beauties," Dr. Marshall A. Howe, assistant director. July 25, "Edible and Poisonous Mushrooms," Dr. Fred J. Seaver, curator. August 1, "Coal, Its Origin and Development," Dr. Arthur Hollick, paleobotanist. August 8, "New Gladiolus Varieties," Dr. Forman T. McLean, supervisor of public education.

RECOGNIZING the need for developing a body of research minded and research trained individuals specializing in textile and allied fields who might be eventually attracted into the textile industries, the directors of the Textile Foundation have authorized establishment of a fund of $100,000 during the next two years to provide for fellowships in textile research.

WARD'S NATURAL SCIENCE ESTABLISHMENT, which was damaged by fire last September, will be restored and maintained by the University of Rochester. The university is reported to have acted in response to requests from scientific men from all parts of the country. The new museum will be housed in a four-story building containing 40,000 square feet of floor space and will be directed by Dr. Dean L. Gamble.

THE Tennessee House of Representatives on June 11 gave approval to the statute prohibiting the teaching of the theory of evolution in schools wholly or partly supported by state funds by rejecting a bill to repeal the law. There were only fourteen votes against the motion to reject the measure and fifty-eight votes in behalf of the rejection.

IT is reported in the New York *Times* that Greenwich Observatory is to be modernized by the addition of a large new telescope of reflecting pattern, with a mirror thirty-six inches in diameter and with a spectroscope also attached. The cost will be defrayed by William Johnston Yapp, of London, a director of the Cariboo Mining Syndicate, Carreras, Ltd., and Consolidated Gold Alluvials of British Columbia. This telescope will require the addition of a new dome to the observatory, and an order for the telescope and the dome will shortly be placed with the British firm of Howard, Grubb and Parsons Company. A new transit-circle apparatus also is to be constructed to replace that built by Sir George Airy in 1851 which proved, in a judgment expressed twenty-five years ago by the late Simon Newcombe, to be "the most serviceable meridian instrument ever constructed." More than 500,000 observations have been made with this instrument in its eighty years, and it is expected the new one will be built by Cooke, Troughton and Simm, Ltd., of London.

FELLOWSHIPS for advanced training in forestry have been awarded by the Charles Lathrop Pack Forest Education Board, of Washington, D. C., to seven foresters, six American and one Canadian, including college seniors as well as older men of long experience. The fellowships range in value up to $1,500, and the men were selected from about 80 applicants. The fellowships were created to encourage men of unusual intellectual and personal qualities to obtain advanced training that would better qualify them for leadership in some phase of forestry. This is the second award of fellowships by the Charles Lathrop Pack Forest Education Board. The fellowships are available to Americans and Canadians for further training in the general practice of forestry, in the forest industries, in the teaching of forestry, in forest research, or in the development of public forest policy. Applications for the third award will be taken next autumn. Further information can be ob-

tained from the Secretary of the Charles Lathrop Pack Forest Education Board, 1214 Sixteenth Street, N.W., Washington, D. C.

THE annual congress of the Royal Institute of Public Health opened on May 19 in the Aula of the Frankfurt University. Some 200 members and delegates of the institute were present, and among the English visitors were Lord Leverhulme, treasurer, and Professor Sir Thomas Oliver, chairman of the Council of the Institute, and Sir William Smith, a former president. Lord Reading, the president, was unable to attend, and his address was read by the British Consul-General. In the course of the address Lord Reading said that the congress had its own international significance and was engaged in war against a common enemy to defeat and destroy disease and to make for better conditions of life, physical, mental and moral, throughout mankind. In its respective spheres it was traveling, even though it may be subconsciously, in the direction all fervently desired to attain—that of peace and good will among men. At a reception held on Wednesday the Chief Burgomaster of Frankfurt, Dr. Landmann, handed Sir Thomas Oliver, for delivery to the Royal Institute of Public Health, the city's highest decoration—the golden plaque—in memory of the fact that Frankfurt was the first German city to be visited by the institute since the war. Sir Thomas Oliver in return bestowed upon the Chief Burgomaster the honorary membership of the institute for his conspicuous services to the institute.

THE ninth meeting of the International Institute of African Languages and Cultures was recently held in Paris. The congress dealt with important linguistic and anthropological problems of the Africa of to-day. Professor Antoine Meillet, president of the Institut d'Ethnologie, acted as president of the congress, and Professor Henri Labouret as vice-president. The members of the council were received by Dr. Charcot, the president of the Geophysical Society of France, and M. Grandidier, secretary-general of the society. At the beginning of the meeting, which lasted for three days, the chairman announced that the Rockefeller Foundation of New York had decided to give to the institute a yearly contribution of £5,000 for five years, plus a further contribution calculated at the rate of £1 for every £2 obtained by the institute from other sources to enable it to carry out further study and research in Africa.

Nature writes that the Royal Dublin Society will celebrate its bicentenary during June, as it was founded on June 25, 1731, at a meeting held in the rooms of the Philosophical Society in Trinity College, Dublin. The society at its foundation was known as "The Dublin Society for improving Husbandry, Manufactures, and other useful Arts and Sciences," and during the two centuries of its existence its activities have ranged over all the subjects included in the original title, and have been extended to include pure science, the fine arts and music. They include such diverse functions as the Dublin Horse Show, recitals of classical music and the provision of radon for therapeutic purposes throughout Ireland. The bicentenary celebrations will be held at the society's headquarters at Ball's Bridge, where ample accommodation is available for the large gatherings that a membership roll of nine thousand is likely to entail, during the period June 23–27. The functions will include an opening conversazione, special scientific and general meetings (the latter on the bicentenary date, Thursday, June 25), a garden party and a period ball. In addition to these functions at Ball's Bridge, their Excellencies the Governor-General of the Irish Free State and Mrs. McNeill have kindly promised to invite the special guests of the society to a garden party which will be held in the grounds of the Viceregal Lodge on Wednesday, June 24. An exhibition will be staged in some of the halls and grounds illustrating the advances made in agriculture, industry, science and art in Ireland during the past two centuries. An interesting feature of the bicentenary week will be the presentation to Sir John Purser Griffith of the Society's Boyle Medal, which has recently been conferred on him in recognition of his work in engineering science.

DISCUSSION

NEW OSTRACODERMS FROM OESEL

LAST summer Dartmouth College generously financed my third expedition to the Island of Oesel in the Baltic Sea, where I hoped to find new material for work begun some forty years ago on the "Origin of Vertebrates." This island is famous for the abundance and beautiful preservation of some of the oldest forms of animal life. Among its fossils of the upper Silurian age are many sea scorpions, or eurypterids, which for untold ages had been the highest animals in existence. Mingled with them are several kinds of ostracoderms, a great class of primitive and highly diversified fish-like animals, which at about this geologic period were making their first appearance on the historic screen. We have for many years regarded the ostracoderms as the remote Cambrian, or pre-Cambrian, descendants of the sea scorpions, and the ancestors of the long line of true fishes, reptiles and mammals which hundreds of million years later culminated in man. For in spite of

the obvious differences between them, the fundamental pattern of bodily structures and functions in all these different forms is essentially the same, and quite unlike that in any other known kind of animals. For that reason, and because of the suggestive sequence of their appearance in geologic time, together with abundant embryological evidence derived from the study of modern representatives, and especially because of the remarkable anatomical evidence provided by the oral arches of the new fossils from Oesel, the ostracoderms and the sea scorpions may now be regarded, beyond any reasonable doubt, as genetically related. In other words they really are the long sought missing links between the highest invertebrates of those very early times and all the vertebrates that arose in subsequent geologic periods. Many fundamental problems of comparative anatomy, embryology, and organic evolution are dependent for their solution on the recognition of the genetic relations of these two great types of animal life.

The paleontological key to the origin of vertebrates is the structure and arrangement of the chief sense organs of the ostracoderms (such as taste, sight, smell and hearing.) and that of the several pairs of jaw-like arches on either side of the mouth. For these grasping and searching sentinels, posted around the main entrance to the body, play conspicuous rôles in the subsequent evolution of the head and face in all the higher vertebrates. And these external features, as always, most clearly express the character of the life within.

There is one little ostracoderm, of which there are many kinds in different parts of the world, in which these organs are enclosed in highly polished and exquisitely modelled bony plates. Although they are usually badly crushed, or scattered about in the muddy sediments now turned to rock, they may, and often do, provide us with exact information as to the nature of these organs, some five hundred million years ago. It was this particular kind of ostracoderm, called Tremataspis, that we were looking for. The animal is about three inches long. It is found only in the island of Oesel, and even there its remains are very rare and always fragmentary.

Our excavations for these fossils were the first ones, on a large scale, that had ever been made in Oesel. We spent some seven weeks in the field, using for most of that time a crew of from fifteen to twenty-seven native workmen, ten hours a day. Four or five feet of rock and soil were removed from an area of about four hundred square yards. The lower, fossiliferous layers, some two or three feet thick, were split into thin slabs, in order, if possible, to locate, or partly expose the more complete specimens without injuring them. The slabs were then broken up into small hand pieces and carefully searched for certain bony plates some of them not much larger than the head of a pin.

After exhausting the old site, near Kiehelkond, we moved to Atla, where there is a peasant quarry recently explored by Professor Luha, an Esthonian geologist from the University of Dorpat. Here we found six new species of ostracoderms. One represents a new family and belongs to a new genus that I have called Dartmuthia. One is a new cephalaspid, and another is a small fish, uniformly covered with loose scales and belonging to an order that looks very strange in these surroundings.

Four of the new forms are as follows:

Tremataspis milleri, n. sp. Branchiocephalic shield, 45 x 36 mm; highly polished; olfactory opening in bottom of deep pit; six to eight dorsal tubercles; occipital crest high, sharp-edged, and overhanging behind. Named after a friend and supporter of the 1928 expedition.

Tremataspis mammillata, n. sp. Shield 39 x 28 mm. Olfactory opening level with or above surrounding surface. Twenty or more small dorsal tubercles.

Didymaspis pustulata, n. sp. Shield about 19 x 29 mm; semi-membranous, flexible; outer surface minutely spiculate; inner surface divided into large, well-marked polygonal areas, with corresponding pustular elevations externally, each one capped with a glistening nodule. Two pairs of marginal areas; distinct oral plates. This form is new to Oesel and gives us for the first time a clear picture of a little known genus.

Dartmuthia gemmifera, n. f., n. g., n. sp. Branchiocephalic shield completely united; 53 x 39 mm; no cornua; one pair of marginal areas. Outer surface smooth and continuous, but divided into minute polygonal areas studded with large gem-like tubercles loosely distributed on dorsal surface, but closely packed on under side of margins, and merging into feather-like ornaments near the gill openings. Ventral post-branchial surface covered with flat, closely united polygonal plates. This represents a new family of ostracoderms, in some respects intermediate between the *Cephalaspidae* and *Tremataspidae*.

The new species of *Tremataspis* and the specimens collected two years ago now give us an almost complete picture of the external structure of these remarkable animals. Two important plates, which I formerly interpreted as parts of oar-like cephalic appendages, have been found in place, united with their associated anatomical parts. One is a convex anal plate, located at the root of the tail and well within the branchiocephalic shield, as in *Bothriolepis*. The other is a fin-like dorsal trunk spine. Nevertheless we have found indications of at least one pair of cephalic appendages on the margins of the circumoral

region. We have also found well-defined membranous flaps protruding from the posterior opening of the branchiocephalic shield in *T. mickwitzi*.

But the most significant discovery was the finding of one and probably two pairs of jaw-like crushing plates in their natural position in two widely different species, *T. mickwitzi* and *T. schmidti*. In both species, they are definitely located on either side of a slit-like longitudinal mouth which is ventral in position, not terminal; and the jaws evidently work sidewise against one another, not forwards and backwards, as they do in typical vertebrates.

Moreover in *Dartmuthia* and *Tremataspis* there are four pairs of conspicuous endoskeletal plates and processes arising from the inner lateral surface of the cephalic shield and pointed towards the mouth. They evidently serve, in part, for the attachment of four sets of muscles and clearly indicate that there are really four non-respiratory oral segments in front of and serially homologous with the eight respiratory gill segments. All this agrees with the location of the several pairs of oral arches (premaxillae, maxillae and mandibles) in the embryos of the higher vertebrates. It also agrees with the postulates and predictions of the arachnid theory of the origin of vertebrates.

WILLIAM PATTEN

DARTMOUTH COLLEGE

THE OCCURRENCE OF OLD MEADOW SOD UNDER THE NEW JERSEY BEACHES

A STUDY of the changes in the position of the shore-line of any coast is very important, but along the New Jersey coast such a study is of particular significance because of the immense amount of money invested in the summer resorts of that state.

There has been some difference of opinion in regard to the question of whether the coast of New Jersey is actually sinking at the present time. Some seventy-five years ago, Dr. George Cook, then New Jersey state geologist, presented evidence which he thought showed that the coast of Cape May County was sinking at the rate of two feet a century or one quarter of an inch a year. Others have expressed the same opinion.

More recently, however, it has been shown that the changes in shore-line may have been brought about by factors other than the subsidence of the land, mainly the erosive action of the waves and currents on the sand beaches. Dr. Douglas Johnson, who has studied the situation thoroughly, says that the evidence favors unusual stability of the land during the past few thousand years.

No matter which interpretation we accept, there still remains undeniable evidence of marked changes in the position of the shore-line along this coast. Cook in the report of the New Jersey state geologist for 1881 pointed out that at numerous places along the coast the wearing away of the beaches had exposed old salt meadow sod on the ocean shore. Since there is no such sod along the shore outside the beaches, this old sod must have grown there when it was a part of the meadow between the beach and the upland, thus indicating a considerable change in the position of the shore-line. At certain places in this sod were to be seen the stumps of old trees, suggesting that the region at one time supported an upland association.

In his volume for 1882 Dr. Cook says that there has been a common report that these meadow sods along the sea border, in some places which were uncovered by violent storms, were plainly marked with the tracks of horses, cattle and sheep. After the severe storm of September 21, 22 and 23, 1882, such tracks were plainly visible a few miles south of Harvey Cedars, Long Beach Island, N. J. They were found in a patch of old meadow sod about three feet below ordinary high-water mark. The sod was thickly marked with the tracks of horses and cattle. The horse tracks were of various but rather small hoofs and without shoes, and the cattle tracks were also of various sizes. The sod and tracks extended back under the hillocks of beach sand.

At that time (1882) that part of the beach had few if any domestic animals on it, but in 1690, when it was settled, horses and cattle were kept on the island which at that time extended considerably farther out to sea.

In the sod near these tracks were seen the stumps of numerous trees and bushes.

Some fifteen years ago, similar tracks of cattle, horses and birds were reported in sod near South Cape May, N. J., exposed after severe storms.

In the last few years patches of this old meadow sod containing the stumps of trees, roots of grass, etc., have been seen in several places along the beach in the vicinity of Cape May. After the heavy seas of early January, 1931, some three feet of sand was eroded from the beach at Cape May Point, exposing the old sod at several places. Stumps of red cedar trees and roots of various plants were seen. Near low-water mark, close to the Cape May Point Coast Guard Station, was seen very clearly the remains of an old corduroy road leading from the present shore-line out toward the sea in the direction of Prissy Wick Shoal, about one mile distant. Tradition says that less than one hundred years ago this shoal was above water and was separated from the present shore-line by low-lying land, and that it was possibly the site of the original Cape May Lighthouse. A study

of maps of the region in the time of the Revolutionary War shows that the land extended considerably farther out than it does at present, and that there was a road approximately in the position of the corduroy recently uncovered; it therefore seems quite probable that this corduroy road is the old road leading to the now submerged Prissy Wick Shoal.

On April 6, 1931, the road was again exposed, this time more distinctly. On a patch of sod, about one tenth of a mile west of the log road, were seen several horse footprints. As far as can be learned, this patch of sod had not been uncovered for at least several years. This locality is about one half a mile distant from the one near South Cape May where the tracks had been seen some fifteen years previously.

The fact that these tracks were of shod horses, while those reported by Cook at Harvey Cedars were of unshod animals, suggests that these tracks may not be quite as old as those previously seen. Nevertheless, the fact that these tracks have persisted in this sod superimposed by a thin layer of sand and covered by the sea twice a day seems interesting and suggestive of how fossil tracks are actually preserved. These horse tracks may possibly be regarded as "fossils in the making."

A more detailed and illustrated account of the occurrence of this meadow sod beneath the New Jersey beaches will be published elsewhere in the near future. This preliminary note is published in the hope that some one may report similar occurrences elsewhere.

HORACE G. RICHARDS
UNIVERSITY OF PENNSYLVANIA

TWISTED TRUNKS OF APPLE TREES

THE recent discussion relative to the twist in the trunks of certain trees has been interesting. I have carefully examined apple trees in orchards from Iowa and Minnesota to New York and Pennsylvania, and have noted that a large percentage of old trees are strikingly twisted. The twist has nearly always been to the right. The variety of apple does not seem to make any difference. It is more likely a matter of age. At least it is more readily seen in the older trees. Soil and position of the orchard does not change the character of the twist. In some orchards nearly 100 per cent. of the trees were twisted. It probably has nothing to do with wind or weather, but is more likely a form of tropism. A great many climbing plants twist in the same direction. Many species of trees also twist the same way. So far as I have observed, a twist to the left is rare. I have been told that in the southern hemisphere the twist is dominantly to the left. If this is so, then the condition is surely the result of the influence of sunlight and position with respect to the equator. In this respect it is like the trade-winds. I am strongly inclined to believe that the twist is the direct result of the influence of sunlight, similar to the turn of the sunflower and the leaves of the compass-plant of the western prairies.

BERTRAM T. BUTLER
COLLEGE OF THE CITY OF NEW YORK

EARLY UTILITARIAN APPLICATION OF TWIST IN TREES

THE twist in the grain of coniferous and deciduous trees discussed by Chas. K. Wentworth in SCIENCE, February 13, and by Arthur Tabor Jones in the issue for March 27 was advantageously adapted to the service of agriculture in America in the 18th and the early part of the 19th centuries. Trees having a left-hand twist were then used in the construction of the mold-board portion of the so-called "wooden plow" of that period.

The length of the mold-board was determined in a measure by the angle of the grain twist since its strength depended upon the extent to which cutting across the grain of the wood became necessary in the shaping of its warped surface. The length of the wooden mold-board was, for this reason, considerably greater than that of the present day all metal plow. Clearly enough a large size hardwood tree having a close left-hand twist was greatly prized by the plow maker as he was able to secure from such a tree the raw material for the mold-boards of several plows.

When the mold-board, land-side, handles and other portions of a plow had been assembled all parts that came into contact with the soil in plowing were armored, or as it was then termed "plated," with thin wrought iron straps and plates formed to fit the wooden parts to which they were riveted. At that time all bolts and their nuts were hand made and were, therefore, more costly than hand-made rivets and key-bolts.

The occupation of "wooden plow" making was entirely confined to the individually owned small-shop period of American manufacturing industry. The plow maker, assisted, possibly, by one or more apprentices—men legally bound by agreement (articled) to his service for a period of years—performed every portion of the work. He selected the twist grain trees in the woods, cut and hauled them to his shop, attended to the proper seasoning of the wood and in the actual manufacturing operations became carpenter and blacksmith in turn. He marketed his finished product and for the most part received therefor other goods in exchange rather than real money.

One of these early American "captains of industry" was a Nathaniel Edwards, who was born June 21, 1752, Haverhill, Mass., and who died June 14,

1828, Casco, Maine. He was commonly known as "Plowmaker Nat."

LLEWELLYN N. EDWARDS
BUREAU OF PUBLIC ROADS,
U. S. DEPARTMENT OF AGRICULTURE

PANAMAN

THE latest editions of the Standard Dictionary and of Webster's International Dictionary give the preference to Panaman as the adjectival form of the word. Both dictionaries give Panamaian (Pan-a-ma-yan) and Panamanian as alternative forms. Both the noun Panama and the adjective Panaman carry the accent on both the first and last syllables, the antepenult and the ultimate, and not on the ultimate alone.

The accented ultimate or final syllable is very common in Spanish proper names and other words, as it is also in Persian place names. When the adjectival form of such a proper name is created in English, however, this adjective becomes subject to the rules of the English language and the accentuation of the original language need no longer be followed. There is much evidence that, in America at least, the accented ultimate is giving way to the accented antepenult, thus, Pan′ a man, with the secondary accent on the ultimate. Incidentally, this seems to be the prevailing pronunciation of the noun Panama among even the well-educated Americans.

CARLETON R. BALL
UNIVERSITY OF CALIFORNIA

CURE FOR FORMALIN POISONING

IN SCIENCE for May 8, 1931, appeared a discussion of formalin poisoning with an appeal for a remedy. About four years ago I developed a most irritating case of this poisoning on my fingers. I tried various remedies and doctors for two years with no success. Then Dr. W. E. Tebbe recommended that I use lanolin. He explained that the formalin kills the sweat glands and that the only way to restore them is to use an animal fat which can be absorbed. The result has been most satisfactory. All trace of the poisoning disappeared in six months. I find that I can handle preserved specimens with safety now if I apply the lanolin at the first indication of irritation.

VESTA HOLT

BARRO COLORADO ISLAND BIOLOGICAL STATION (1930–31)

THE seventh annual report of this tropical biological station, as presented by Dr. Thomas Barbour, chairman of the executive committee of the Institute for Research in Tropical America, includes the following items covering the year ending February 28, 1931.

Several additions to the plant are reported, particularly a building at the end of the Pearson Trail. This structure is made entirely of lumber treated by the zinc-meta-arsenite process as a termite resistance experiment in cooperation with the Curtin-Howe Corporation, which controls the process, and the Bureau of Entomology of the U. S. Department of Agriculture. It is fully equipped for use as a residence by any visiting naturalist and located in the vicinity of innumerable bayous and with great diversity of habitats near at hand. The mangosteens and other planted trees are growing finely, the trails have been well cleared, bridges put in good condition and in general the plant is in excellent order.

Mr. Zetek, the indefatigable resident custodian, has prepared a card index of all publications referring to the island, arranged by author and subject, and is continuing the species index begun last year. It is requested that all investigators inform him at the earliest possible time of identifications that are made. Since the species index was started, Dr. Herbert N. McCoy has twice given financial assistance. Several other donations consisting of apparatus are mentioned.

A condensed statement of the facilities which the laboratory offers and the concessions granted workers by the government of the Panama Canal and by steamship companies, etc., has been printed and may be obtained from the office of the chairman (Dr. Thomas Barbour, Museum of Comparative Zoology, Cambridge, Massachusetts) or resident custodian. There have been no changes in the steamship arrangements announced in the last annual report, when they were discussed in full. One misstatement, however, was made at that time; the special rate offered by the United Fruit Company is $75 per round trip, and not each way.

A list of seventeen investigators in residence at the laboratory for extended periods during the year is included in the report, together with brief statements of their studies. The published papers resulting from studies at the laboratory now total 148 as compared with the 118 titles last year. The current additions are listed with comments in special cases, and there are lists of the mammals, molluscs, termites, fruit flies and trypetidae. The amphibia and reptilia are listed as known from the Canal Zone as a whole.

Under "Present Needs" it is stated that "the island is badly in need of a simple electric installation to furnish light and power. The dynamo should be located on the dock where fueling would be convenient and this innovation would not only be a great convenience and an aid for work in the evening, but would enormously lessen our fire hazard. The total cost would not exceed $750 for a one and one half kilowatt unit."

The greatest need of the laboratory is an adequate endowment. At the present time nine institutions are subscribing for tables at $300. Donations total $600, and there are various minor sources of income which make the total receipts $5,583.10. An endowment that would be modest compared with that of many biological laboratories would greatly increase the effectiveness of the station. Dr. Barbour believes "there is no place in the world where so small a sum would so greatly aid biological research." The following resolutions adopted by the Inter-American Conference on Agriculture, September 13, 1930, illustrate the esteem in which the studies being conducted and those possible at Barro Colorado Island are held by tropical agriculturalists:

The Inter-American Conference on Agriculture, considering that

Whereas, the Department of Agriculture of Porto Rico, the experiment station of the United Fruit Company in Tela, Honduras, and the biological station in *Barro Colorado*, in the Canal Zone, have been conducting investigations along special lines of tropical agriculture and forestry, and making the results of this work available as far as possible to several Latin American countries;

Resolved, (1) To express appreciation for these valuable services, and the hope that they will be further expanded, and that in the future closer cooperation will be established with other experiment stations and agencies of scientific research in the countries of America.

(2) That an endeavor be made to obtain the cooperation of the experiment stations in the countries of America now equipped to render a Pan American service, such as the experiment stations of Porto Rico, the experiment station of the United Fruit Company in Honduras, the Barro Colorado Island Biological Station in Panama, and stations in other countries of America which have facilities for such services for special investigations of problems the solution of which is most urgent for agriculture, forestry and animal husbandry in the countries of tropical America.

There is the further need of support for studies without immediate utilitarian possibilities. To this end the Institute for Research in Tropical America, which is the organization legally back of the Barro Colorado Laboratory, is seeking an endowment of $100,000. This proposal received endorsement by the executive board of the National Research Council at its meeting in April, 1931. The laboratory has demonstrated its usefulness and should be relieved of its present financial uncertainties.

W. C. Curtis,
Chairman Division of Biology and Agriculture, National Research Council

QUOTATIONS

THE CAPPER AWARD

When Ossian heard "the call of years" he lamented that no bard would "raise his fame." But the great entomologist Dr. L. O. Howard, whose middle name recalls the legendary Gaelic hero of the third century, needs no poet to sing his deeds in fighting for a half century the forces which "constitute to-day our greatest rivals in the control of nature"—the injurious insects. He has been recognized in a more substantial and significant way: he has been awarded the Capper Gold Medal for distinguished service to agriculture, and through it to those who live by it or on its fruits. The award also includes an honorarium of $5,000.

No one in all the world better deserves such recognition than this entomological warrior in "the oldest war in history," between mankind and the insect myriads. The only hope that the human race has of winning is in uniting its scientific forces in research and attack and in dividing the enemy—encouraging conflicts among the insects themselves, even nourishing parasitic battalions in laboratories to prey upon other insects and so maintain a balance that will permit crops to grow, flowers to bud and blossom, trees to bear fruit and the "higher" creatures to live and pursue happiness.

Dr. Howard has been and is a master of such strategy in fighting these lilliputian enemies, which are much more experienced in the ways of this planet, having lived here, as he reminds us, 50,000,000 years, while man arrived barely 500,000 years ago, and are "the most perfectly adapted of all creatures to live under all sorts of conditions." Fortunately for man, they fight among themselves and prey upon one another—the fleas on smaller fleas, and so on, as Jonathan Swift said in reporting the naturalist's observations, *ad infinitum.* But the surpassing achievement of this master entomologist has been to recruit insect allies and mercenaries from the lower biological orders for his campaigns against specific pests, even bringing them from other lands and sending American expeditions overseas to aid other countries.

Yet the warfare is not over. A few years ago Dr. Howard estimated that the annual loss due to the ravages of insects in the United States alone exceeded $2,000,000,000, nullifying the labor of 1,000,000 men annually. And as to the recruiting by the

enemy, he quotes approvingly even later and astounding statistics which assert that the plant lice descended from one individual of one species in a single season, where there is enough food, would weigh more than five times as much as all the people of the earth.

The award to Dr. Howard calls attention not only to his valiant service as a leader in this warfare, but also to the importance of the struggle in the agricultural world, where only the ingenuity of man can prevent the supremacy of the insect.—*The New York Times.*

SOCIETIES AND ACADEMIES

THE ILLINOIS ACADEMY OF SCIENCES

THE twenty-fourth annual meeting of the Illinois State Academy of Science was held in Peoria on May 8 and 9, 1931. General addresses were given on the following subjects:

"Research, Its Opportunities and Rewards," F. R. Jelliff, Galesburg, retiring president.

"Genesis of an Industry," W. Hoskins, Chicago.

"Physics and Physical Chemistry," T. R. Hogness, University of Chicago.

"Chemical Messengers," A. C. Ivy, Northwestern University Medical School.

"From Chance to Certainty in Education," F. G. Blair, Superintendent of Public Instruction, Springfield.

"Saving Illinois Streams from Pollution," H. F. Ferguson, Department of Public Health, Springfield.

The following resolution was adopted:

Realizing the large value and great importance of research along many lines and the benefits accruing to the people from inventions, explorations and discoveries in science, often the result of patient, persistent and painstaking endeavor, resolved that the Illinois State Academy of Science, while fully appreciating the recognition accorded such work, would respectfully recommend that Congress add to this the establishment of financial awards for the most noteworthy and valuable inventions and discoveries in the several branches of science, to be bestowed under such conditions as Congress may direct.

The officers elected for the year 1931–32 were:

President: Fay-Cooper Cole, University of Chicago.

First Vice-president: Frank C. Baker, University of Illinois.

Secretary: Harold R. Wanless, University of Illinois.

Treasurer: George D. Fuller, University of Chicago.

Librarian: A. S. Coggeshall, State Museum, Springfield.

Editor: Dorothy E. Rose, State Geological Survey, Urbana.

The following were chosen as chairmen of committees:

Membership: D. L. Carroll, State Geological Survey.

Affiliation: H. J. Van Cleave, University of Illinois.

Ecological Survey: A. G. Vestal, University of Illinois.

Conservation: H. C. Cowles, University of Chicago.

Legislation and Finance: F. R. Jelliff, Galesburg.

State Hall of Fame: M. M. Leighton, State Geological Survey.

Sectional chairmen selected for the next annual meeting are:

Zoology: F. C. Hottes, Millikin University, Decatur.

Physics and Chemistry: C. L. Cross, Illinois State Teachers' College, Normal.

Geology: T. E. Savage, University of Illinois.

Geography: Mabel Crompton, Illinois State Teachers College, Normal.

Psychology and Education: M. M. Maynard, Monmouth College, Monmouth.

The meeting was attended by about 800, including a large delegation of the junior section of the academy. Science exhibits prepared by high-school students were shown. Geological, biological and industrial field trips were taken to points of interest near Peoria on May 9.

H. R. WANLESS,
Secretary

THE TENNESSEE ACADEMY OF SCIENCE

THE spring meeting of the Tennessee Academy of Science was held at the University of Tennessee, in Knoxville, on Friday and Saturday, May 8 and 9. East Tennessee was represented on the program with sixteen papers and Middle Tennessee with nine. After a dinner on Friday evening the members by invitation of the University Student Body attended a lecture by Mr. Lorado Taft, sculptor, on "My Dream Museum." At the dinner Professor H. A. Webb substituted with a humorous pseudo-scientific narrative for Dr. E. E. Reinke, who on account of illness was prevented from giving an address on "A Mountain Station in the South for Biological Research." A trip to the Bird Preserve, near Knoxville, scheduled for from 6 to 8 o'clock Saturday morning and an excursion to the Great Smoky Mountains for Saturday afternoon had to be given up on account of a downpour of rain.

Mr. Henry Colton and Dr. L. C. Glenn were appointed a committee on State Aid to the Academy. The editor of the *Journal* was authorized to proceed

on a policy of increasing the exchange list and as he sees best respecting advertising in the *Journal*. Mr. Latimer J. Wilson was elected a delegate to the meeting of the American Association for the Advancement of Science at Pasadena in June, and Dr. J. T. McGill to the meeting at New Orleans in December.

The officers of the Academy for 1931 are:

President: L. R. Hesler, University of Tennessee, Knoxville.

Vice-president: H. A. Webb, George Peabody College, Nashville.

Editor: Jesse M. Shaver, George Peabody College, Nashville.

Secretary-Treasurer: John T. McGill, Vanderbilt University, Nashville.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A TRANSPARENT ELASTIC GLUE, USED IN MAKING CHAMBERS FOR INSERTION IN THE RABBIT'S EAR

IN connection with the new methods for studying the growth and reactions of living cells and tissues in the living mammal, originated and developed under the direction of Dr. E. R. Clark, it became necessary to find a satisfactory glue or cement substance which would fasten together various parts of the transparent chambers used for insertion into the rabbit's ear.

The first type of these chambers was developed by Dr. J. C. Sandison ('28)[1] and was made entirely of kodaloid, and the various parts were stuck together by parlodion. Later a number of workers in this laboratory collaborated on various improvements in the technique in order to obtain standardized chambers which would give uniform results and would be adapted to various types of observation and of experiment (Clark, Kirby-Smith, Rex and Williams, '30).[2] The thin kodaloid top proved to be unsatisfactory for such standardized chambers because of its tendency to warp and to allow the escape of moisture. Glass covers were much too fragile. Mica proved to be a satisfactory substitute as regards thinness and clearness, and the finding of a satisfactory glue to seal mica to heavy kodaloid or glass, used in the bases and supporting rings of the chamber, has obviated the chief difficulties inherent in the use of mica in the earlier chambers (Sandison, '24).[3]

A satisfactory glue for use in the construction of the chambers had to meet a number of requirements. It was necessary for it to be permanently adhesive and to be impervious to and unaffected by fluids, including the natural tissue fluids and antiseptic solutions such as phenol, hexyl-resorcinol and metaphen, and to be uninfluenced by moderate changes in temperature. In addition, it was highly desirable for it to be elastic, transparent and smoothly clear (without bubbles).

A large number of experiments were carried out before a glue which meets all these requirements was obtained. Balsams and resins of different varieties were tried with many different solvents. A number of varnishes and shellacs were also experimented with. Different commercial cements were tried. Celluloid compounds in different mixtures and combinations were used. Some of these substances, such as glyptal, passed the tests with water, but failed after the chamber was placed in one of the disinfecting solutions, or after insertion in the ear. Others (especially the cements such as Duco) were successful in sticking mica to glass, but had a tendency to warp the heavy kodaloid and to form bubbles.

The present glue forms a permanent, tenacious cement. It is smooth, transparent and waterproof, is unaffected by the moisture of the animal's tissues, by various antiseptics, or by moderate changes in temperature, and possesses the added advantage of elasticity. It will stick mica to kodaloid, to glass or to silver, kodaloid to glass or silver, and glass to glass.

The ingredients used and method of preparing the glue are as follows:

Pure gum copal (in lumps, *not* powdered)
Venice turpentine
Xylol

Select lumps of the copal which are clear and light amber in color. Heat copal in a porcelain dish until melted. While still over the flame, add a small amount of Venice turpentine and stir well. (The amount of Venice turpentine depends on the desired flexibility of the cement). Turn off the flame and continue stirring while adding xylol in small amounts. Some of the xylol evaporates, and it is therefore advisable to add a little xylol continuously while the

[1] J. C. Sandison, "The Transparent Chamber of the Rabbit's Ear, Giving a Complete Description of Improved Technic of Construction and Introduction, and General Account of Growth and Behavior of Living Cells and Tissues as Seen with the Microscope," *Am. J. Anat.*, Vol. 41, No. 3, p. 447, 1928.

[2] E. R. Clark, H. T. Kirby-Smith, R. O. Rex and R. G. Williams, "Recent Modifications in the Method of Studying Living Cells and Tissues in Transparent Chambers Inserted in the Rabbit's Ear," *Anat. Rec.*, Vol. 47, No. 2, p. 187, 1930.

[3] J. C. Sandison, "A New Method for the Microscopic Study of Living Growing Tissues by the Introduction of a Transparent Chamber in the Rabbit's Ear," *Anat. Rec.*, Vol. 28, No. 4, p. 281, 1924.

cement is still hot. On cooling, the cement may become hard. This indicates an insufficiency of xylol, and it is then necessary to reheat the mixture and add more xylol. When cool the glue should have the consistency of molasses.

In applying the glue a small camel's hair brush is used. The consistency of the glue allows plenty of time to apply it smoothly and in the exact amount required.

Copal glue thus prepared is not sufficiently tenacious to hold pieces together when strong forces are exerted which tend to separate the pieces. Consequently it can not be used for the original type of chamber described by Sandison, which was glued together before insertion into the ear. But it is tenacious enough to hold together either the tops or the bottoms of the newer types of chamber, since the forces exerted are such as to press the glued portions closer together, while the forces which act so as to separate the top from the bottom are resisted by nuts and bolts.

When parts of the transparent chambers have been cemented in the manner described recently (Clark *et al.*, '30) it is necessary for them to stand for at least 24 hours—preferably longer—before insertion in the rabbit's ear, on account of the susceptibility to irritation on the part of living tissues toward a trace of free xylol.

Although up to the present time this glue has been used only for the purpose for which it was invented, its qualities should prove useful in sealing total mounts, especially of specimens cleared in oil of wintergreen.

Thanks are due to Dr. S. E. Pond for information regarding types of glues, to Dr. O. V. Batson, who suggested the use of copal, and to Dr. E. R. Clark, at whose instigation the studies were made.

B. B. VARIAN

SCHOOL OF MEDICINE,
UNIVERSITY OF PENNSYLVANIA

CELLOPHANE COVERS FOR PETRI DISHES FOR KEEPING OUT CONTAMINATIONS AND STUDYING THE EFFECTS OF ULTRA-VIOLET LIGHT

ORDINARY petri dishes, with loosely fitting glass covers, are not altogether satisfactory for use in research on pure cultures of certain organisms, particularly fungi, because of the difficulty of preventing contaminations. By means of a simple technique covers of cellophane may be applied, making it possible to keep the cultures almost indefinitely without danger of contamination. Furthermore, they may be examined as often as desired under the low power of a microscope, without exposing them to contamination, for the flexibility of the cellophane makes it possible to bring the objective close to the organism.

In addition to maintaining the purity of cultures, cellophane offers a tremendous advantage in the investigation of the effects of ultra-violet light on various organisms in pure culture. Ordinary glass covers transmit hardly any of the ultra-violet spectrum, and the best of the special ultra-violet transmitting glasses are impenetrable to the very short wavelengths. Cellophane, on the other hand, is nearly as transparent to the extreme ultra-violet as air, and as it is only .025 to .03 mm thick, the percentage transmission, as compared to air, must be close to 100. Cultures may thus be irradiated by any wave-length of ultra-violet, from the shortest to the longest, over any length of time and for any duration of exposure, by placing an appropriate filter on the cellophane cover, without exposing the culture to contamination. In some experiments, now almost complete, conducted on several species of fungi, some very interesting results were obtained by means of this procedure. It is a distinct improvement over former methods, in which the glass cover of the petri dish was removed in order to study the effect of the extreme ultra-violets.

The application of the cellophane covers is quite simple and not time consuming. The percentage of contaminated cultures, after a period of a month, was reduced from about 20 per cent. to 0.5 per cent. by applying cellophane covers according to the following method. Some of the cultures were carried around in the pockets of my coat for several days without subsequent contamination.

The cellophane is cut into square sheets, about 6 by 6 inches, and sterilized by placing in 60 per cent. alcohol in a flat glass dish for half an hour. The cultures are inoculated in the usual manner. It is necessary to exercise some care in transferring the cellophane onto the petri dish. Best results are obtained by placing the petri dish culture next to the dish containing the cellophane saturated with alcohol, lifting the top of the petri dish with the thumb and forefingers and then drawing a sheet of cellophane across the top of the bottom part of the petri dish with the third and fourth fingers, thus avoiding at any time exposing the culture to any bacteria or spores that might otherwise fall into it. The glass cover can now be replaced to press down the cellophane, and then removed again and a rubber band applied to hold the cellophane around the sides. If this is done carefully, no alcohol will get into the medium, and in a few minutes it will evaporate out of the cellophane, leaving it perfectly dry, transparent and tightly stretched across the top of the dish. If the culture is to be kept for any length of time,

it is necessary to replace the glass cover of the petri dish to keep the medium from drying up. It may be removed, however, as often as desired, in order to examine the culture with a microscope, or irradiate it with ultra-violet light. Cultures can be conveniently labeled with india ink directly on the cellophane.

FRANK H. JOHNSON

PRINCETON UNIVERSITY

SPECIAL ARTICLES

THE EFFECTS OF BREED ON GROWTH OF THE EMBRYO IN FOWLS AND RABBITS

T. C. BYERLY[1] has recently made an important study of the weight of chick embryos in two different breeds of domestic fowls and in their reciprocal hybrids. He reaches the conclusion that breed does not affect the size of the embryo except as it affects the size of the egg previous to incubation. This is contrary to the conclusion reached by Painter[2] and by Castle and Gregory[3] in the case of the rabbit, which leads Byerly to question the correctness of the rabbit findings.

In the rabbit studies it had been found that the size of the egg at the time of fertilization is no greater in Flemish Giant rabbits than it is in Polish (a very small breed), but that the average birth weight of a Flemish Giant is nearly double that of a Polish. It is obvious accordingly that Flemish embryos increase in weight faster than Polish embryos prior to birth, as they are well known to do subsequently. Since there is no discoverable difference in cell size between Flemish and Polish rabbit embryos (Painter), it is clear that the former must contain *more* cells, and this means that cell multiplication must proceed more rapidly in the development of *Flemish than in that of Polish rabbits.* Castle and Gregory have found such a difference in evidence as early as 48 hours after mating. Byerly questions the adequacy of the data submitted in support of this conclusion. To this criticism we offer no objection at this time because we have made additional observations, which will be presented in a paper[4] now in press, showing that the difference in number of blastomeres and in mitoses is clearly present at still earlier stages, *viz.*, 40 and 41 hours after mating.

The case of the chick embryo is more difficult because the size attained by the embryo at the time of hatching, which corresponds roughly with the birth weight of the rabbit, is strictly limited by the weight of the egg prior to incubation. A large chick can not hatch from a small egg. Nevertheless, it is possible to derive from Byerly's observations clear indications as to whether breed (*i.e.*, genetic constitution), does or does not influence embryo size prior to hatching, while there is still an unexhausted supply of nourishment for the embryo to draw upon.

[1] *Jour. Morphol. and Physiol.*, 50, December, 1930.

[2] *Jour. Exp. Zool.*, 50, 1928.

[3] *Jour. Morphol. and Physiol.*, 48, September, 1929.

[4] *Jour. Exp. Zool.*, 59, April, 1931.

The two breeds studied by Byerly in pure matings and in reciprocal cross matings were White Leghorn and Rhode Island Red, which for brevity we may call the White and the Red breeds, respectively. Red hens average about one third larger than White, or as 100 : 138 in mean body weight. The mean egg weight of the Red breed was also slightly greater, 60.5 grams as compared with 58.4 grams, the mean egg weight of the Whites. Whether the energy content of the Red egg is greater is unknown, as the relative weight of shell and relative size and composition of the yolk are unknown. Byerly directs his attention chiefly to a comparison of the weight of the embryo when removed from the yolk in White as compared with Red eggs throughout the incubation period. It appears from his observations that the blastoderm of the egg, when removed from the yolk, prior to incubation is heavier in the White breed than in the Red. For the White breed, the mean weight is 0.0030 grams; for Reds, 0.0028 grams. Whether the difference is due to a larger amount of formed cellular material[5] or to a larger amount of adhering yolk is unknown, but whatever its nature, the difference persists throughout the first nine days of incubation, in which the embryos taken from White eggs are slightly heavier than those taken from Red eggs. Subsequently, *i.e.*, from the 10th to the 19th days of incubation, the Red embryos are heavier. This is shown both in Byerly's Table 1 summarizing his more numerous observations and in his Table 3 summarizing the data obtained under specially controlled conditions, "from hens of the same age and receiving the same diet, from eggs of the same weight and incubated in the same incubator at the same time."

Nevertheless the hatching weight of chicks in the two breeds is substantially the same, which points to total egg size as a factor limiting the size of the chick prior to the time that it begins to receive nourishment from other sources.

The more rapid growth of Red embryos, after the initial handicap of a smaller blastoderm had been overcome, and before total egg size had entered as a limiting factor just prior to hatching, is completely

[5] Possibly in the White breed cell increase in the blastoderm proceeds farther than in the Red breed before coming to a standstill previous to incubation. If so, we can understand why this initial advantage persists for several days before the more rapid growth rate of the Red breed overtakes it.

in harmony with the observations made on rabbits, in that it shows that the embryo of the larger breed grows faster when other conditions are equal.

Another and even clearer indication that breed (genetic constitution) affects the rate of growth of the embryo throughout the entire period of incubation (even before endocrine organs are established) seems to have been overlooked by Byerly. This is the more rapid growth of crossed as compared with uncrossed embryos. The difference in blastoderm composition in the two breeds prior to incubation, which obviously influences embryo weight up to the ninth day of incubation, may be completely eliminated by confining the comparison to the eggs of one breed at a time, comparing the size of embryos produced in White eggs fertilized by White males with that of embryos produced in White eggs fertilized by Red males, and also comparing the size of embryos produced in Red eggs fertilized by Red males with that of embryos produced in Red eggs fertilized by White males. In both cases Byerly's observations show the cross-bred embryos to be preponderantly heavier, whether the mother was White or Red.

The White eggs opened each day (Table I) range in number from 10 to 75 in each series (pure-bred and cross-bred). The pure-breds average heavier on 4 of the 19 days of incubation, *viz.*, the 2nd, 8th, 16th and 18th. On the 15 remaining days, including both the first and the last, the cross-bred embryos are heavier.

The observations made on Red eggs are less numerous but point to the same conclusion. The cross-bred embryo is in general heavier. The number of cross-bred embryos studied is smaller and does not cover every day of the incubation period, ranging from 4 to 11 embryos per day, but its indications are clear. The period covered is from the 2nd to the 19th days of incubation, omitting the 6th and 7th, and the 13th, 14th and 15th. Cross-bred embryos are heavier on all except two (the 9th and 18th) of the 13 days sampled.

As to the hatching weight, that of the cross-breds is slightly greater in the Red series and slightly less in the White series. Here available nourishment within the egg comes in as a limiting factor. If this were removed, by taking body weights a few weeks subsequent to hatching, cross-breds would undoubtedly be found again heavier, as is well known from other observations.

The specially controlled series of embryos produced by Byerly, from eggs of the same size incubated simultaneously side by side, summarized in his Table 3, confirms the conclusions based on his more general series summarized in Table I. The number of embryos studied is smaller, ranging from 2 to 14 per day in each of the four series, but the conditions under which they were produced make their evidence particularly important. Embryos from the eggs of White hens mated with White males are heavier on 3 of the 12 days sampled; *viz.*, the 2nd, 3d and 12th; cross-bred embryos from the eggs of White hens mated with Red males are heavier on the other nine days (4, 5, 8, 9, 10, 11, 16, 17 and 19). Embryos from the eggs of Red hens mated with Red males are heavier on 4 of the 12 days sampled; *viz.*, 9, 11, 16 and 19; cross-bred embryos from the eggs of Red hens mated with White males are heavier on the other eight days (2, 3, 4, 5, 8, 10, 12 and 17). With the small number of embryos examined, it is evident that random sampling affects the results here more than in Table I, which included larger numbers; nevertheless the general trend of the observations is clear and consistent with the results of Table I. *Other things being equal, a cross-bred embryo grows faster than one not cross-bred.*

There is, we think, no escaping the conclusion based on Byerly's own observations that breed (genetic constitution) does influence growth rate and through it body size. Embryos of the larger breed grow faster as soon as they have attained an even start. Also eggs of the same breed laid by the same flock of hens under identical conditions, if fertilized by males of their own breed, produce smaller embryos than are produced if fertilization is accomplished by males of the other breed. Are the cross-bred embryos heavier because they contain more cells or larger cells? We may take our choice of these alternatives. If they contain more cells, then cell multiplication must occur more rapidly in the larger embryo, exactly as it does in rabbits. If one chooses to assume that the cells are larger rather than more numerous in cross-bred embryos, the burden of proof rests with him, for Painter has not found it so in rabbits, but in any case it is obvious that a cross-bred embryo grows faster than one not cross-bred in birds as well as in rabbits.

W. E. CASTLE
P. W. GREGORY

BUSSEY INSTITUTION,
HARVARD UNIVERSITY

THE EFFECT OF DIET ON HOOKWORM INFESTATION IN DOGS[1]

THE investigations summarized in this brief preliminary report give an experimental demonstration

[1] From the department of helminthology of the School of Hygiene and Public Health of the Johns Hopkins University. This work was made possible by the aid of the International Health Division of the Rockefeller Foundation.

of a definite correlation in dogs between undernourishment and susceptibility to infection with the common dog hookworm, *Ancylostoma caninum*. They also show that hookworm infestations which develop in dogs on a deficient diet can be practically eliminated by placing them on an adequate diet.

The routine dog diet used in our laboratory consists of pig lungs, milk, bread and water. Small amounts of cod liver oil are added to this diet for puppies and for the experimental dogs when changed from a deficient diet. The deficient diet used, which was suggested by Dr. H. D. Kruse of the department of chemical hygiene of this institution, consists of 35 per cent. of corn starch by weight, 35 per cent. of dried ground peas, 29 per cent. of Mazola oil, 1 per cent. of NaCl (C. P.) and an abundant supply of water. This food was always given in sufficient quantities to satisfy hunger, the significant fact being that it is very deficient in vitamines and important minerals.

The course of the infestations in the dogs was carefully followed by fecal examinations by the Lane method and the Stoll dilution egg counting technique, and the total fecal output of each animal was routinely screened for the recovery of any worms passed.

In the first experiment, five dogs were used. Two of them had been born in the laboratory and the other three had been in the laboratory since they were only a few weeks old. These five dogs had been used by Dr. O. R. McCoy[2] for studies of resistance to hookworms in animals which had been given repeated infections. When they were turned over to us for the diet experiments, they were all full grown, 9 to 16 months old and had very slight infestations. They were practically immune to further infection with the dog hookworm due to age and the long series of previous infections to which they had been subjected. In all five cases, the resistance was so pronounced that doses of 4,000 or more infective hookworm larvae produced no increase in their worm burden, as measured by eggs in the feces. In one case a single dose of 500,000 infective larvae resulted in no increase in egg production at a time when eggs in the feces could only be detected at all by the most careful examinations.

These five animals were all placed on the deficient diet at the same time. In spite of treatment, they all harbored a few worms at the beginning of the experiment. Two of these dogs with no additional infections began to show a considerable increase in daily output of hookworm eggs in their feces after about ten weeks on the poor diet. This was interpreted to mean that worms already present were enabled to produce more eggs as the host was affected by the poor diet. This same thing was shown by three other dogs in a later experiment not included in this paper. These dogs had been given infestations while on a good diet. After the curves of the egg counts had gone down to a low level in the natural course of the infestation, they were placed on the deficient diet and were given no further doses of larvae. Not long afterwards their egg counts increased very considerably indicating an increased egg production in the worms that remained. This finding fits in well with some of McCoy's results in which he found that the egg production of worms in resistant dogs was about one third of those in susceptible dogs.

After these first two dogs had shown the increased egg production on the deficient diet, they were treated until negative. Then after twenty weeks on this diet they were each given 500 infective hookworm larvae by mouth. After a normal prepatent period, they became positive and their egg counts rose rapidly reaching peaks of egg production comparable to those previously reached when they were susceptible puppies. In fact in one case the egg production was much greater than that produced by the earlier infections. These two dogs were transferred to the good diet after 149 days on the deficient diet with the egg output still at the peak. They rapidly regained their weight and general health and there was a rapid reduction in daily egg production, the egg count curves falling almost to zero in a period of only four weeks on the good diet. Numbers of worms were spontaneously lost after the egg production had dropped to a few thousand eggs per day. This phenomenon is suggestive of a dietary cure of hookworm in dogs. Following this spontaneous cure, repeated doses of larvae failed to produce any significant infestations showing that resistance to hookworms was regained.

The other three dogs on the first experiment were handled somewhat differently. Although previously treated, they still harbored a few worms when placed on the deficient diet. After they had been on this diet for ten weeks, they were each given a single dose of 500 infective hookworm larvae. Again after the normal prepatent period they became positive and the egg counts rose rapidly reaching peaks of egg production comparable to those produced by infections when they were susceptible puppies. These dogs were then treated until they were negative for hookworms before being returned to the good diet. This change of diet soon increased their weight and also restored their resistance since repeated doses of hookworm larvae failed to produce significant infestations.

The point to be emphasized is that all five of the dogs in the first experiment, which had been

[2] O. R. McCoy, *Am. Jour. Hygiene*, 1931 (in press).

shown to be resistant to enormous doses of infective hookworm larvae while on an adequate diet, quickly lost their resistance and developed rather heavy infestations when given 500 larvae each after ten or twenty weeks on the deficient diet. Two of them when transferred to the good diet while still harboring large numbers of worms expelled them in a short time.

A second experiment with two dogs, which were estimated to be about two years old, was carried out in a somewhat different way. These two dogs were brought into the laboratory as pregnant females and were kept on the good diet about two months before the puppies were born and while they were being nursed. During this period, they were treated and later found to be negative to hookworms by repeated examination. While still on the good diet, they were each given 500 infective hookworm larvae by mouth. Both remained negative to repeated examinations for a period of six weeks, which indicated that they were very resistant to the hookworm. At this time, they were put on the poor diet and given repeated doses of 500 larvae at intervals of two weeks, the first dose being given two weeks after they had been placed on the deficient diet. After prepatent periods of 19 and 17 days, respectively, or after 33 and 31 days on the poor diet, they became positive. The egg counts increased with each subsequent infection until the number of eggs given off per day was about 700,000 for one dog and 900,000 for the other. At this time, 90 days after they had been placed on the deficient diet, they were transferred to the good diet. The doses of larvae at the two-week intervals were continued as before. But in spite of these constant doses of larvae, the egg counts in both dogs came steadily down until they reached a low level. In each case numbers of worms were lost after the egg counts had been greatly reduced. These two dogs are of especial interest since they show first the rapid breaking of the resistance in old dogs on the poor diet, and then a cure and a regaining of the resistance when they were placed on the good diet in spite of continued doses of infective larvae.

In the experiments outlined above, a definite correlation is demonstrated between deficiency in diet in dogs and susceptibility to infection with the dog hookworm, *Ancylostoma caninum*. The undernourished condition is characterized by lowered resistance to infection, increased rate of development of the worms and increased egg production per worm. When the dogs that had acquired an infestation while on the deficient diet were transferred to the good diet their recovery of resistance was indicated by a reduced egg production of the worms present, a spontaneous loss of worms and a resistance to further infection. It seems possible from this and other evidence that a similar relation may exist between the human hookworms and their hosts. We suspect that it will be found that heavy infestations are more easily built up in people on poor diets, and that not only the effects of the worms on the hosts may be reduced, but also the worms themselves may be partially or wholly eliminated by improvement in diet alone.

A. O. FOSTER
W. W. CORT

THE JOHNS HOPKINS UNIVERSITY

FURTHER STUDIES ON THE ADRENAL CORTICAL HORMONE[1]

THE work herewith reported was done upon dogs with the adrenal cortical hormone prepared according to the method of Swingle and Pfiffner.[2] The material does not contain adrenalin in excess of 1 to 1,500,000. A series of bilaterally adrenalectomized dogs maintained in good health for considerable periods with the cortical hormone were then injected with gradually decreasing doses of extract (subcutaneous, one dose each day), the dose being changed at five-day intervals. One dog was maintained for a period of five days on 1/6 cc per kg weight per day, the others on 1/4 cc per kg weight per day without symptoms of insufficiency. We regard 1/4 cc therefore as the minimal maintenance dose for a single injection per day in dogs weighing 10 to 15 kg.

Extensive experiments have been made on the blood concentration and urinary excretion of various inorganic substances and of the nitrogenous compounds, following the injection of cortical extract into normal dogs, and into adrenalectomized animals. In the normal dogs we have been entirely unable to detect characteristic changes in the blood constituents which we have followed. Carbon dioxide content and capacity (alkaline reserve), oxygen capacity, nonprotein and urea nitrogen, creatinine, sugar, calcium, potassium and magnesium, cholesterol, lactic acid, plasma chlorides, hematocrit and plasma proteins, examined in arterial blood samples are not altered in any definite or quantitative manner. The determinations have been made at hourly intervals following injection, up to five hours and at the end of twenty-four and forty-eight hours. Stress should be laid, we believe, on the fact that we have used trained animals at rest, strictly in fasting condition. There was no change in the respiratory metabolism (oxygen consumption, or R.Q.) in a normal animal so injected within five hours or at the end of twenty-four hours. The amount of extract injected has varied

[1] Aided in part by a grant from the Josiah Macy, Jr., Foundation of New York.

[2] W. W. Swingle and J. J. Pfiffner, *Anat. Record*, xliv, 225, 1929; *Am. Jour. Physiol*, Vol. 96, 1931.

from 1 cc to 7 cc per kg. One animal received a single intravenous injection of 100 cc of extract and showed no changes.

Bilaterally adrenalectomized dogs which are treated with adequate daily dosage of the adrenal cortical extract do not differ in their behavior, or in the blood concentration of the substances mentioned, from normal animals. Weight is maintained, appetite, pulse rate at rest, and rectal temperature is normal, and the body skin and hair are kept in fairly good condition.

When the bilaterally adrenalectomized animal, in a good state of nutrition, with well-healed wounds and without infection, is deprived of adequate injections of cortical extract, either abruptly or by gradual reduction of dosage to less than 1/6 cc per kg daily, the first significant change we have observed is a rise in blood non-protein nitrogen and urea. This is coincident with or may precede by a few hours the refusal of food, and definitely precedes the drop in respiratory metabolism which is also a constant observation. Changes in blood creatinine do not occur until the animal is very ill. The serum potassium concentration rises steadily during the period of insufficiency. The secretion of urine diminishes markedly and there is a suppression of urinary nitrogen and urea. The chloride and inorganic phosphate excretion is suppressed when the animal begins to refuse food and if the insufficiency is allowed to go to the point where urinary secretion is very low or almost suppressed there is a diminution of creatin and creatinine excretion as well as that of injected phenol sulphonephthalein. In the earlier stages of insufficiency, however, suppression of total nitrogen and of urea nitrogen occur before the excretion of creatinine and creatin lessens. No microscopic changes are found in the urine, but small amounts of albumin are quite regularly present during insufficiency. Marked and rapid loss of weight occurs where there is diarrhea or vomiting. The muscular weakness, lowering of body temperature, characteristic gait, and psychic symptoms of dogs in advanced insufficiency have been adequately described by various writers. Lowering of the systolic blood pressure does not usually occur until after the nitrogen retention has become well established. In animals which subsequently recover, following injection of adequate amounts of extract, the oxygen consumption may drop at the time of maximum insufficiency to 20–25 per cent. below the normal value at which time the R.Q. also has fallen to 0.72–0.71. Injection of extract is then followed by a diuresis which may last for 48–96 hours and is accompanied by increased excretion of urinary nitrogen and urea, and of chlorides. At the same time the animal gains rapidly in weight and his appetite returns. The respiratory metabolism usually returns slowly and the R.Q. more rapidly to their original levels. These changes precede or approximately parallel the return of the blood non-protein nitrogen and urine excretion nitrogen to their previous values. The fall in serum potassium concentration parallels that of the non-protein nitrogen. The delay in return to normal of this blood non-protein nitrogen and urea appears to be more marked following each subsequent period of adrenal insufficiency, a phenomenon which we have also noted in clinical studies on Addison's disease to be reported later.

We are now utilizing the early change in blood non-protein nitrogen and urea as a means of biological assay of the strength of different lots of cortical extract in adrenalectomized dogs. Studies of the effect of the extract and of its deprivation upon kidney function and upon anatomical renal damage are also in progress.

G. A. HARROP
J. J. PFIFFNER
A. WEINSTEIN
W. W. SWINGLE

THE JOHNS HOPKINS UNIVERSITY HOSPITAL AND MEDICAL CLINIC, BIOLOGICAL LABORATORY, PRINCETON UNIVERSITY

BOOKS RECEIVED

BENSIN, VASIL M. *Agrooecological Study of the Maize Root System.* Pp. 517–577. 45 figures. Czechoslovak Academy of Agriculture.

COLLINS, A. FREDERICK. *Experimental Mechanics.* Pp. xvi + 302. 167 figures. Appleton. $2.00.

FISH, FLOYD H. *The First Course in Quantitative Analysis.* Pp. x + 120. Blakiston's. $1.25.

HACKER, LEONARD. *Cinematic Design.* Pp. 191. Illustrated by Constance Hacker. American Photographic Publishing Company, Boston. $2.50.

HOOTON, EARNEST A. *Up from the Ape.* Pp. xvii + 626. 58 figures. 28 plates. Macmillan. $5.00.

KYOTO IMPERIAL UNIVERSITY. *Memoirs of the College of Science.* Series A, Volume XIV, No. 2. Pp. 43–78. Illustrated. Maruzen Company, Tokyo.

LEVINSON, HORACE C. and EARNEST B. ZEISLER. *The Law of Gravitation in Relativity.* Second edition. Pp. 126. University of Chicago Press. $3.50.

MOULTON, FOREST R. *Astronomy.* Pp. xxiii + 549. 213 figures. Macmillan. $3.75.

PALMIERI, MARIO. *Relativity; an Interpretation of Einstein's Theory.* Pp. 87. Forbush Publishing Company.

PARK, CHARLES F. *A History of the Lowell Institute School.* 1903–1928. Pp. xi + 192. Harvard University Press.

PELLETT, FRANK C. *American Honey Plants.* Third edition, revised. Pp. 419. 204 figures. American Bee Journal. $3.00.

ROBERTS, FRANK H. H., JR. *The Ruins at Kiatuthlanna, Eastern Arizona.* Pp. viii + 195. 47 plates. Smithsonian Institution, Bureau of Ethnology.

SHULL, A. FRANKLIN. *Heredity.* Second Edition. Pp. xv + 345. 143 figures. McGraw-Hill. $3.00.

TOKYO IMPERIAL UNIVERSITY. *Bulletin of the Earthquake Research Institute.* Volume IX, Part 1. Pp. 114. Illustrated. The University.

SCIENCE

VOL. 73 FRIDAY, JUNE 26, 1931 No. 1904

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE FUNCTIONAL ACTIVITY OF SINGLE UNITS IN THE CENTRAL NERVOUS SYSTEM[1]

By DR. J. F. FULTON

LABORATORY OF PHYSIOLOGY, YALE UNIVERSITY SCHOOL OF MEDICINE

WITH the recognition of the neurone as the ultimate anatomical unit of the nervous system it came to be tacitly assumed that all nervous and mental phenomena are, in the last analysis, explicable in terms of the combined activity of single nerve elements. Individual neurones, however, had, until very recently, eluded isolation as functioning entities, and knowledge of the intimate details of their behavior was therefore lacking. Without this information it was quite impossible to form a satisfactory conception of the elementary principles of nervous activity, and many details of reflex action remained obscure. Single *muscle* fibers, to be sure, had been studied by Lucas, Pratt and others to great advantage, and single axones had been placed under direct observation by using artificial stimulation (pore electrode), but these studies gave little or no information concerning the characteristics of the nerve cell itself. The responses of a single intact neurone, activated within the central nervous system by a natural stimulus, were first placed under direct observation in 1928, and since then notable progress has been made in the analysis of their behavior. The quest of a single neuro-muscular unit has in fact had many of the dramatic features associated with the quest of the single atom, and the success achieved by the physiologist is in most respects quite as remarkable as that of the physicist.

Isolation of the unit was made possible largely by virtue of the electrical response accompanying activ-

[1] Schiff Foundation Lecture, Cornell University, April 17, 1931.

ity. The potentials developed by such microscopical units are small, but with modern valve-amplification this is a matter of little consequence; a much greater difficulty has been the anatomical isolation of the unit from the myriad of similar structures—nerve cells, nerve fibers, muscle fibers—surrounding it. This special problem is well exemplified by the early work on the voluntary electromyogram. Since every muscle fiber gives rise to an electrical response during activity, numerous and large electrical deflections can be obtained from a muscle, *e.g.*, the human biceps, during voluntary effort. A large number of studies concerning the nature of such electrical variations were carried out with capillary electrometer and later with the Einthoven galvanometer, and the attempt was made by Gotch, Piper, Garten, Forbes, Adrian and others, to infer the characteristics of activity of the individual nerve cells which had thrown the muscles into voluntary activity. In the early literature much of the discussion turned upon the existence of an alleged rhythm of approximately 50 per second which was commonly seen in the voluntary electromyogram (Fig. 1). At best, however, it was an

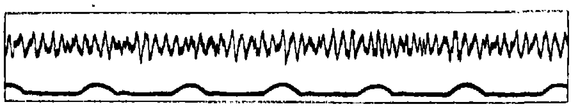


FIG. 1. An electromyogram of voluntary contraction of the flexor muscles of the forearm obtained by Piper. Note the rhythm of approximately 50 per sec. Time 0.20 sec. (H. Piper, "Über die Ermüdung bei willkürlichen Muskelkontraktionen." *Arch. f. Anat. u. Physiol.*, 491–498, 1909.)

"impure" rhythm, for there were many subsidiary vibrations ("secondary waves") thought to be due to elements out of phase with the majority. The real difficulty lay not here, but in the interpretation of the "primary" (50 per sec.) waves. There was no clear proof that they represented the responses of single units; it was quite possible that rotation of activity occurred among individual elements and that any given neurone might respond at a much lower rate than that indicated by the 50 per second rhythm. I had occasion six years ago to review the subject in some detail, and, in view of these and other considerations, I ventured at that time to make the following prediction:[2] "Not until the responses of individual units can be recorded singly will electrical records give a decisive answer as to rate of discharge of spinal motor neurones. Already, however, (1925) Adrian and Zotterman have succeeded in recording the action currents of a single proprioceptive afferent nerve fibre responding to an adequate stimulus (stretch) applied to its end-organ. In addition to the importance of so great a technical achievement, it also promises that a definitive solution of the long-debated question of the intrinsic rhythm of spinal centers may be reached in the near future." The inference was an obvious one and I can take little credit for its unexpectedly prompt justification, since it has come about through the ingenuity and foresight of other investigators.

While studying the stretch reflex[3] of the red fibered soleus muscle (cat), Denny-Brown[4] observed that on applying very slight degrees of stretch to the tendon a regular sequence of small galvanometer deflections was obtainable from the muscle (Fig. 2). He correctly interpreted these as being due to the activity of the group of muscle fibers innervated by a *single* anterior horn cell of the spinal cord. When the stretch stimulus was slightly increased a second group of action currents usually appeared maintaining a different rhythm from the first, and therefore waxing and waning with the first series of deflections (Fig. 2). It was quite evident that the second series of deflections represented the activity of an additional motor unit. With further stretch more units come in and the electrical deflections ultimately become quite confused and irregular.

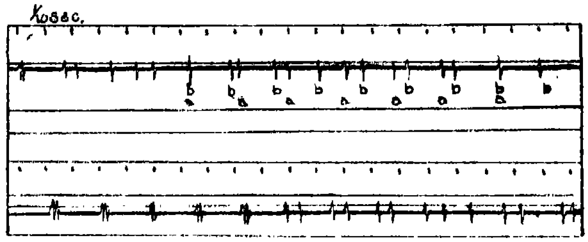


FIG. 2. The electrical response of single units of soleus muscle responding to slight stretch; string galvanometer record unamplified. In A the unit 'a' drops out toward the end of the record and unit 'b' persists. In B the waxing and waning of two units discharging at slightly different rates is clearly seen (Denny-Brown).

Working independently of Denny-Brown, Adrian and Bronk[5] succeeded, at approximately the same time, in obtaining from nerve the action currents of single discharging units. Their observations as to rate of discharge, waxing and waning of discrete rhythms, etc., entirely confirmed, and in some respects

[2] J. F. Fulton, "Muscular Contraction and the Reflex Control of Movement," Baltimore: Williams & Wilkins, pp. 477–478.

[3] E. G. T. Liddell and C. S. Sherrington, "Reflexes in Response to Stretch (myotatic reflexes)," *Proc.* Roy. Soc. B/96: 212–242, 1924.

[4] D. E. Denny-Brown, "On the Nature of Postural Reflexes," *Proc.* Roy. Soc., B/104: 252–301, 1929.

[5] E. D. Adrian and D. W. Bronk, "The Discharge of Impulses in Motor Nerve Fibers. Part II. The Frequency of Discharge in Reflex and Voluntary Contractions," *Jour. Physiol.*, 67: 119–151, 1929.

(to be considered later), considerably extended the work of Denny-Brown. Before describing the details of these important observations, we must pause to discuss the anatomical basis of the so-called "motor unit." It was a matter of some surprise to realize that a string galvanometer, without the aid of valve-amplification, was capable of registering the action currents from such a unit.

THE MOTOR UNIT[6]

Denny-Brown's observation was in harmony with the belief that a motor nerve fiber, through peripheral bifurcation, generally innervates a relatively large number of muscle fibers. However in 1928 very few direct observations were available from which an exact calculation could be made. The early (1873) estimates of Tergast[7, 8] and others had not taken into consideration the existence of a large proportion of sensory fibers in muscle nerves. But in the case of the tenuissimus muscle it was evident from the data of Porter and Hart[9] and Adrian,[10] that as many as 140 to 160 muscle fibers must be innervated by a single motor nerve fiber.[2] This presupposed extensive peripheral dichotomy, the existence of which was made quite clear by the observations of Cooper,[11] who studied the peripheral ramifications of motor nerve fibers in the frog and the cat. She encountered many instances of double branching and one instance of "trichotomy."

The problem of complete enumeration of all of the fibers in a given muscle with a view to determination of the "innervation ratio" has recently been undertaken by D. A. Clark.[12] Using cats whose hind limbs had been desensitized by removal of all appropriate posterior root ganglia (in which therefore complete degeneration of all sensory fibers had occurred), he was able to count the motor nerve fibers accurately, and he developed an ingenious method for enumerating all of the muscle fibers, using two representative muscles, soleus and extensor longus digitorum. For soleus an innervation ratio of 1 to 120 was established and for extensor longus digitorum 1 to 155. This means that when a single anterior horn cell supplying the soleus muscle discharges, on an average 120 muscle fibers are thrown into action. This readily accounts for the facility with which Denny-Brown was able to secure action currents of a single unit.

One of the first questions that presents itself relates to the *tension* value of such a group of muscle fibers. How much tension can a single unit develop? It is obvious that this value will impose an absolute limit to the degree of fractionation of which the central nervous system is capable in respect of the muscle which it controls. Chronologically this particular problem was considered before the ratios of Clark were established, in a paper by Eccles and Sherrington[13] published in June, 1930.

Using deganglionated preparations they measured, by means of an accurate torsion-wire myograph, the total tension developed during a twitch and in a tetanus of a group of representative muscles including soleus, extensor longus digitorum, and gastrocnemius. Afterwards, the motor nerve fibers supplying the muscle in question were enumerated and the value so obtained was divided into the total tension development previously observed. The figures arrived at for the tetanus were surprising and are indicated as follows:

	Gm.	No. units
Gastrocnemius (medial head)	30.1	430
Soleus	9.9	200
Semitendinosus	5.5	630
Extensor longus digitorum	8.6	330
Crureus	10.2	250

For the *twitch*, values of approximately a third to a quarter of this amount were obtained. It is thus evident that a single anterior horn cell of gastrocnemius is capable of controlling as much as 30 grams of tension, being larger the larger the animal. On the basis of Clark's enumeration for soleus and extensor longus digitorum, it was possible to calculate a number of additional values, *i.e.*, weight per muscle fiber, and tension per muscle fiber, as indicated in the following table taken from his paper.[12]

Eccles and Sherrington also made a number of significant observations concerning the dichotomy of motor nerve fibers; thus on enumerating the number of mylinated fibers at various levels between the spinal cord and a given muscle, they observed a considerable

[6] The phrase "motor unit" was introduced in 1925 by Sherrington who later defined it as follows: "The muscle and its nerve may be thought of as an additive assembly of 'motor units,' meaning by 'motor unit' an individual motor nerve fibre together with the bunch of muscle fibres it innervates."

[7] P. Tergast, "Ueber das Verhältniss von Nerve und Muskel," *Arch. f. Mikros. Anat.*, 9: 36–46, 1873.

[8] Tergast observed one nerve fiber to about three muscle fibers in the eye muscles of sheep, but a ratio of 1: 80 to 1: 120 for the limb muscles of the dog.

[9] E. L. Porter and V. W. Hart, "Reflex Contractions of an All-or-None Character in the Spinal Cat," *Am. Jour. Physiol.*, 66: 391–403, 1923.

[10] E. D. Adrian, "The Spread of Activity in the Tenuissimus Muscle of the Cat and in Other Complex Muscles," *Jour. Physiol.*, 60: 301–315, 1925.

[11] S. Cooper, "The Relation of Active to Inactive Fibres in Fractional Contraction of Muscle," *Jour. Physiol.*, 67: 1–13, 1929.

[12] D. A. Clark, "Muscle Counts of Motor Units: A Study in Innervation Ratios," *Am. Jour. Physiol.*, 96: 296–304, 1931.

[13] J. C. Eccles and C. S. Sherrington, "Numbers and Contraction-Values of Individual Motor-Units Examined in Some Muscles of the Limb," *Proc. Roy. Soc.*, B/106, 326–357, 1930.

Muscle	Weight per muscle fibre	Tension per muscle fibre	Tension per nerve fibre	Innervation ratio
	mgm	mgm	grams	
M. soleus	0.122	84.0	9.9	1 : 120
M. extensor longus digitorum	0.072	48.5	8.6	1 : 165

increase in the more peripheral cross-sections. This is well indicated in their diagram (Fig. 3) of the

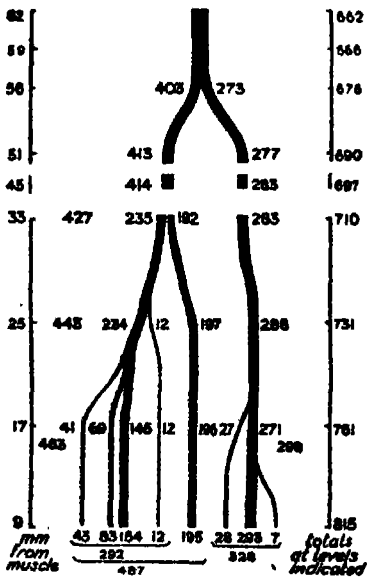


FIG. 3. Eccles and Sherrington's diagram showing their enumerations of fibers in the nerve to gastrocnemius medialis during 53 mm of its course toward the muscle.

deafferented nerve to gastrocnemius medialis, observed during 53 mm of its course toward the muscle. At the beginning it had 662 motor fibers and at the distal point examined, 815.

Eccles and Sherrington also observed that the motor fibers fell into two groups with respect to their size, a large number of approximately 4 μ and a second group of roughly 14 to 15 μ. Both groups come through the anterior root and were unaffected by removal of the sympathetic ganglion chain. The presumption is that both the large and the small fibers innervate muscle fibers in the usual way through motor end-plates, and the question naturally arises as to the reason for these differing diameters. In studying the incidence of dichotomy Eccles and Sherrington found that the largest fibers were the earliest to divide in their course from spinal cord to muscle and that dichotomy was seldom encountered among the fibers of small diameter except it occur relatively near their ultimate terminations.

They were inclined therefore to believe that the large fibers, through extensive dichotomy, form the largest motor units. The small fibers, forming smaller motor units, serve to make the delicate adjustments necessary for muscular coordination. Eccles and Sherrington also infer that the total area of the large fibers gives an index of the total number of muscle fibers which they supply. Though only 66.3 per cent. in point of numbers, the large group form 92.4 per cent. of the total cross-sectional area. The presumption, therefore, is that the majority of units are large.

Denny-Brown was aware that the tension developed by single units was of the order of magnitude of 1 to 20 gms, but his levers did not permit accurate determination. The average contraction-tension per motor unit for the twitch of soleus in one of Eccles and Sherrington's anatomical estimates was 2.48 gms. With a specially devised eye-muscle myograph (torsion-wire pattern) Eccles and Sherrington[13] were able to obtain stretch reflexes of varying sizes in response to a momentary tap on the table to which the muscle was fixed. A twitch-like response often appeared which was seldom less than c. 2.0 gms in tension (Fig. 4), and, if the tap were more intense,

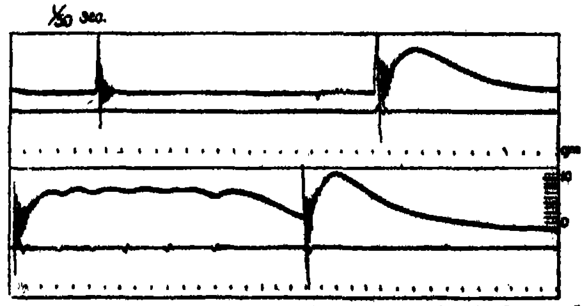


FIG. 4. Simultaneous electrical and mechanical record of units (2 to 3) of the soleus muscle (decerebrate cat) responding to a momentary tap. In the lower record a tetanic response is seen (Eccles and Sherrington).

larger responses occurred which, on measurement, proved to differ from one another by increments of 1.5 to 2.5 gms; thus in one of their figures showing a series of responses, the tension values were as follows: 0, 0, 2.5, 2.5, 4, 6.5, 6.5, 6.5, 6.5, 7, 8.7, 10.5 gms. From this they conclude (p. 352), "There seems no reason to doubt that the 2.5 gm. responses are twitches of single motor-units, and the 4 gm. responses of 2 units. Continuing the series it seems likely that 6.5–7 gm. is given by 3 units, 815 gm. by 4 units, and 10.5 gm. by 5 units. In this series 2.5 gm. is the greatest tension of a single unit and 1.5 gm. is the smallest. Further observations during the experiment accorded perfectly with these values; in all cases 1.5 or 2.5 gm. was the tension produced by a single unit." Occasionally in their experiments a firm tap

was not followed by a rise of tension (Fig. 4); in such a case there was no electrical response from the muscle, and, as they point out, this serves as an admirable control to the experiment: *i.e.,* there was either a response of *c.* 2.0 gm on the tension record associated with a 1 to 2 mm on the electrical record, or no response in either.

In some of their records *repetitive* responses (Fig. 4) were obtained involving single units, and the greatest tension registered did not exceed 10.4 gm and varied between that value and *c.* 7.0 gm. This is within the range which one would anticipate from the average contraction-tension per motor unit worked out on anatomical grounds (see above).

RATE OF DISCHARGE OF THE ANTERIOR HORN CELL

The most important disclosure from study of single units is their relatively slow rate of discharge. From observations on the voluntary electromyogram, and more particularly from reflex electromyograms in animals (in which responses had been taken *en masse* from the muscle as a whole), it had been inferred that nerve cells may discharge at rates varying from 50 to 500 per sec. It is certainly significant that with isolated units in "tonic" contraction no rhythm higher than 25 per sec. has ever been observed, and the majority have shown rates varying from 5 to 20 per sec.; thus, in Denny-Brown's record (Fig. 2), the first unit was discharging at 7 per sec. and the second at 5.5. In Eccles and Sherrington's tetani of soleus the highest rate seen was 13.7 (Fig. 4). To be sure, these observations were made on soleus, a relatively slow muscle, but the remarkable work of Adrian and Bronk[5] confirms the values obtained, and we now propose to consider this work in detail.

By carefully dissecting a nerve trunk under a binocular microscope, Adrian and Bronk found it possible to transect all but two or three fibers so that only these remained in functional continuity with the nervous system. Leads were then taken from the nerve at points distal to the dissection, and with valve-amplification the responses of individual fibers were readily recorded by means of a capillary electrometer. Various muscle nerves were then examined under different forms of stimulation. During a *flexor* reflex (decapitate cat), evoked by pinching the foot and recorded from the nerve to peroneus longus, the discharge in a single unit was at first very slow, *e.g.,* 5 or 6 per sec., attaining at the end of 1 to 2 seconds a rate of 18 to 20 per sec., again subsiding as the stimulus of the foot was diminished (Fig. 5). In an *extensor* nerve (decerebrate preparation), *e.g.,* that to vastus lateralis, individual units were readily obtained which at rest discharged continuously for long periods at 20 to 25 per sec.; at the height of a crossed

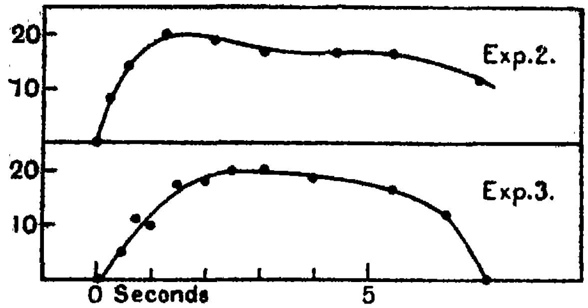


FIG. 5. Adrian and Bronk's curve illustrating the variation in the rate of response of a single unit of peroneus longus during a flexor reflex. *Exp. 2,* decapitate preparation; *Exp. 3,* decerebrate with spinal transection.

extensor reflex the rate might rise as high as 80 to 90 per sec., never above 100. This showed quite clearly that the stronger the stimulus, the more rapid the rate of discharge, and it was evident from this that *rate* of discharge is a highly important factor in the grading of contraction in skeletal muscle. It is a fact of some significance that alterations in rate were more readily demonstrated in extensor muscles than in flexors, for the extensors are called upon for more delicate adjustments of posture and movement than is generally required in the more primitive flexor reactions.

By another ingenious device Adrian and Bronk[5] have succeeded in recording single muscle fiber groups in muscles whose nerves were not artificially cut down. They employed the expedient of a concentric needle electrode consisting of a small hypodermic needle into which was inserted a No. 36 gauge enamel wire (193 μ in diameter), the outside of the hypodermic needle forming one electrode and the exposed cut surface of the enamel wire, the other. In this way they suc-

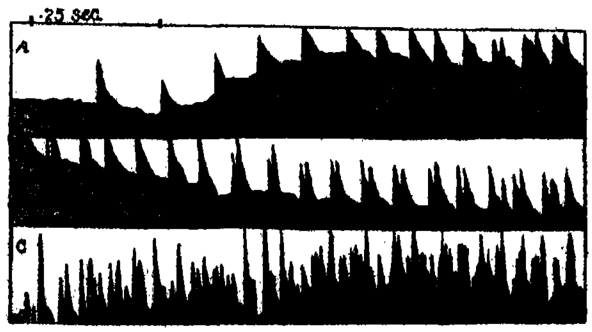


FIG. 6. Record of the development of a voluntary contraction of the human triceps obtained with the concentric needle electrode. In A one unit is responding, at first slowly and then more rapidly; a second unit then appears which in B is seen waxing and waning with the first. In C a large number of units are discharging (Adrian and Bronk).

ceeded in obtaining single and double units during voluntary contraction of human arm muscles (Fig. 6). Not infrequently a contraction began at a rate of 5 or 6 per sec., gradually increasing in magnitude as the contraction became stronger, ultimately reaching 30 or 40 per sec., and occasionally as much as 50. There was no evidence of a predominant 50 per sec. rhythm such as one sees when the muscle mass is examined as a whole (Fig. 1). Once more they demonstrated marked grading of rate during the development of contraction. With this technique they also re-examined certain muscles of the cat, including solcus, confirming Denny-Brown, and they also observed in quadriceps that a "tonic" discharge at a rate of 9 or 10 per sec. might persist for long periods of time without alteration in rate. Denny-Brown had indicated quite clearly that these so-called "tonic" responses were in reality stretch reflexes, for they disappeared when the muscle was caused to relax. Though its rate during a stretch reflex is usually remarkably constant, it may be diminished by application of a weak inhibitory stimulus (Denny-Brown), and I have several times seen soleus units slow down before dropping out of action on turning the head of the preparation away from the recording muscle, a manoeuvre which diminishes the resting tonus in the extensor muscles on that side (Magnus and de Kleyn).

With these characteristics of discharge in mind it is apparent that if more than a few fibers are brought into action, each one discharging asynchronously at a variable rate, the electrical result will be a complex series of deflections which would utterly defy analysis. Such records are readily obtained on gradually increasing a stretch reflex; first one unit, then another, later three or four come in, and ultimately a number so large that the electrical record is meaningless. The important outcome of the analysis of the rates of discharge are twofold: (1) Gradation of activity may be achieved, especially in extensor muscles, by variation in rate of discharge; (2) tonic responses are maintained by rates of discharge ranging from 5 to 15 per sec., at which rate a fiber can go on discharging indefinitely, apparently without fatigue.

OTHER CHARACTERISTICS OF THE MOTOR UNIT

Through analysis of the deafferented tibialis anticus muscle of the cat responding reflexly to two suitably timed, single break-shock stimuli applied to one of the afferent nerves of the hind limb, Eccles and Sherrington in a very recent series of studies[14,15,16,17,18] have thrown much new light upon the functional activity of the units involved in the flexor reflex. For convenience of designation we propose to follow their convention of referring to the first stimulus as C_1 and the second stimulus as C_2.

Latent period.—They have confirmed the determinations of Jolly, and Forbes and Gregg for the "central reflex time" of the flexor reflex to C_1 as falling within the range of 2.75 to 4.35σ, the period being briefer the stronger the stimulus. If, however, C_2 falls within 4 to 36σ of C_1 the latency of C_2 is markedly diminished, and they have proved that the diminution occurs at the expense of the central reflex time. In some experiments it became as brief as 0.5σ, of which a small fraction must be due to conduction time within the nervous system, and the writers therefore conclude that the latent period of individual neurones may, in response to a second stimulus, be as brief as 0.2σ.

Refractory period.—Some writers have assumed that the neurone is without a refractory period. The work of Eccles and Sherrington indicates that this is emphatically incorrect. In their analysis of the reflex response of tibialis to two centripetal volleys they found, when C_1 was sufficiently strong, that C_2 produced a response of varying size depending upon the C_1C_2 interval, being least effective at about 14σ after C_1 (Fig. 7). They have brought forward a

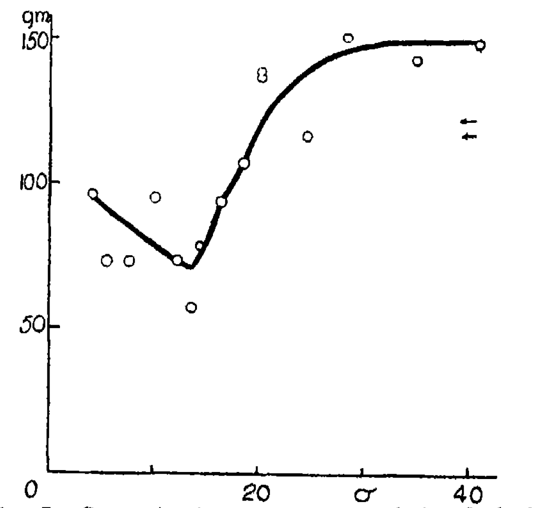


FIG. 7. Curve showing the tension evoked reflexly in tibialis anticus by a second stimulus following at intervals of 4 to 40σ after another stimulus of equal intensity. Note the "minimum" at 14σ.

series of convincing arguments to show that the greater effectiveness of C_2 at intervals less than 14σ

[14] J. C. Eccles, "Studies on the Flexor Reflex. III. The Central Effects Produced by an Antidromic Volley," *Proc.* Roy. Soc., B/107: 557–585, 1931.

[15] J. C. Eccles and C. S. Sherrington, "Studies on the Flexor Reflex. I. Latent Period," *Proc.* Roy. Soc., B/107, 511–534, 1931.

[16] *Idem.* II. "The Reflex Response Evoked by Two Centripetal Volleys," *Ibid.*, 535–556.

[17] *Idem.* IV. "After Discharge," *Ibid.*, 586–595.

[18] *Idem.* V. "General Conclusions," *Ibid.*, 596–605.

is due to calling into action units not discharged by C_1 but which had been facilitated by that stimulus ("the subliminal fringe,").[19] Units discharged by C_1 are refractory during the greater part of this period. Following C_1, therefore, two opposing processes go on concurrently in the center: (1) Dissipation of "facilitation" in the neurones of the subliminal fringe, and (2) recovery of excitability in neurones discharged by C_1. This readily accounts for the "minimum" in the response, and the fact that it should occur at 14σ gives a clue to the approximate duration of the refractory period.

The evidence for this interpretation turns largely upon the response of the motor unit to an *antidromic* volley of impulses, *i.e.*, produced by a single stimulus applied to an intact (but deafferented) motor nerve. Eccles[14] has shown that when a motor axon is stimulated in the reverse direction the anterior horn cell is made refractory to centripetal stimuli for a period of 10.5σ, of which 2.5σ represents an absolutely refractory period and *c.* 8σ a relatively refractory period. This new disclosure is one of considerable importance and has thrown quite a new and unexpected light upon the physiology of the neurone. When an antidromic stimulus is applied so as to reach the anterior horn cells between C_1 and C_2 (C_1C_2 interval being less than 14σ, *i.e.*, less than the "minimum") the response to C_2 was largely abolished even though the refractory period (10σ) of the antidromic volley could have had little effect. It is concluded from this that normally the response of C_2 must have depended upon an enhancement of the excitatory state produced in certain neurones by C_1 but not actually discharged by that stimulus. Eccles concludes also that an antidromic volley removes, in subliminally excited neurones, all traces of a preformed central excitatory state and causes the neurones affected to be refractory for a period of 10.5σ. The refractory state so produced is held to be identical with the refractory period following the normal discharge of a neurone. The slight discrepancy between the magnitude of the two values (10.5σ as compared with 14 to 15σ, the relatively refractory period of the reflex arc) is probably due to the greater degree of temporal dispersion of activity incident to stimulation of centripetal volleys.

When an antidromic volley falls during an after-discharge[17] a period of complete quiescence occurs lasting not less than 20 to 50σ which is too long a period to be explained by the central refractory period and must therefore be due to removal of the central excitatory state responsible for the repetitive discharge. In these circumstances all neurones are affected at once and the first sign of activity following the antidromic volley gives evidence of the least interval between successive impulses of the rapidly firing units. When the interval is as great as 50σ it clearly shows that no unit is discharging at a rate greater than 20 per sec. A second corollary is that after-discharge *per se* "depends on the continued arrival of delayed excitatory impulses" rather than on a supraliminal excitatory state. This places the cause of after-discharge further upstream in the reflex arc than the axon hillock of the anterior horn cell, but leaves it still one of the unsolved mysteries of reflex physiology.

Eccles and Sherrington's analysis of the reflex responses evoked by two closely concurrent centripetal volleys indicates that under strong repetitive stimulation from any source the summated rhythm, *e.g.*, the 50 per sec. response in the voluntary electromyogram, is probably due to an asynchronous rotation of units rather than to a group of units discharging at the observed rate. Adrian and Bronk's direct observations on the single unit in voluntary contraction of the human forearm indicate that the rate of discharge is highly variable and that little or no significance can be attached to the rates of discharge previously observed in the voluntary electromyogram.

THE CENTRAL EXCITATORY STATE

The recent experiments of Eccles and Sherrington allow us to reconsider the problem of excitation within the nervous system. They point out that the central excitatory process has many characteristics in common with the so-called local excitatory process in peripheral nerve, "Thus it seems likely," they remark, "that the central excitatory state is a specialised manifestation of the local excitatory state (*cf.* Sherrington, 1921). According to the membrane theory, the latter is a partial depolarisation of the polarised membrane surrounding the axis cylinders of nerve fibres, so on analogy central excitatory state is probably a depolarisation of those parts of the surface membranes of motoneurones on which the excitatory impulses impinge, *i.e.*, the synaptic membranes."

There can be no doubt as to the close parallel between the central excitatory state and the local excitatory process in nerve. They are both due presumably to a local concentration of ions at a previously polarized interface but it seems to me necessary to draw a sharper distinction than Eccles and Sherrington have done between the polarized interface and the action upon it of ions leading to ex-

[19] D. E. Denny-Brown and C. S. Sherrington, "Subliminal Fringe in Spinal Flexion," *Jour. Physiol.*, 66: 175–180, 1928. See also, C. S. Sherrington, "Some Problems attaching to Convergence." (The Ferrier Lecture). *Proc.* Roy. Soc., B 105, 332–362, 1929; *idem.*, "Quantitative management of Contraction for 'Lowest-level' Coordination." (The Hughlings Jackson Memorial Lecture). *Brit. Med. Journ.*, i, 207–212, 1931.

citation. If the site of accumulation of ions responsible for the central excitatory state were the diffuse peripheral boundary of the nerve cell, which is inherent in their interpretation, I find it very difficult to understand how it is possible for an excitatory impulse reaching the cell at one point to summate with a similar impulse reaching the cell at a distant point; unless there is some special process of local conduction along the surface of the cell, this would be virtually impossible. If, on the other hand, one assumes a site of accumulation of ions common to impulses reaching the cell from every point and that all influence impinges ultimately at this point, the difficulties are minimized. I would urge further that the sharply circumscribed characteristics of refractory period, rate of discharge, etc., presupposes a discrete controlling center within the cell. However, the allocation of the central excitatory state to the region of the synapse has the logical advantage of placing it at the surface of the cell along which conduction is believed to occur. In offering an alternative interpretation, I do so, fully recognizing the inherent objections facing any theory of central excitation at the present time.

Conclusion

Single motor units, *i.e.*, anterior horn cells plus the muscle fibers they innervate, have recently been placed under direct observation while responding to a normal reflex stimulus. Details such as the normal rate of discharge, latent period, refractory period, influence of fatigue, etc., have been carefully studied. The work of Denny-Brown, Adrian and Bronk, Eccles and Sherrington have all indicated that the natural rate of discharge of the anterior horn cell is slow, *i.e.*, 5 to 25 per sec., and never more than 80 to 90 per sec. under intense stimulation. A motor unit discharging at 10 per sec. may continue in activity for indefinite periods of time without fatigue. Tonic responses are maintained by such rates of discharge and therefore no special tonic mechanisms need be postulated to explain the absence of fatigue.

An individual anterior horn cell may, through peripheral bifurcation of its axon, command 150 or more muscle fibers, and it may, in consequence, develop during natural tetanus, a tension of 20 to 30 gms (*e.g.*, units of gastrocnemius medialis). In soleus, a red "postural" muscle,[20] the ratio of nerve to muscle fibers is 1 to 120 and the average tension value of the unit 10 gms. Direct observations of the tension developed by single units confirm the values obtained through anatomical averages.

The neurone has a refractory period of 10 to 15σ, which accounts for its normal slow rate of discharge. When an axon is stimulated antidromically[14] the neurone becomes similarly refractory for a period of about 10.5σ and all evidence of a central excitatory state is removed by such a stimulus. The central excitatory state has many properties in common with the local excitatory process.

[20] D. E. Denny-Brown, "The Histological Features of Striped Muscle in Relation to its Functional Activity," *Proc. Roy. Soc.*, B/104: 371–411, 1929.

A RECENT DRIFT IN BIOLOGICAL THOUGHT[1]

By Professor WM. A. KEPNER
UNIVERSITY OF VIRGINIA

At the close of the nineteenth century mechanism prevailed. The heavens no longer declared the glory of God but rather the marvelous phenomena that had accidentally transpired within the cosmic test-tube. Even the mind of man was but an epiphenomenon. It was the rattle of machinery. William Keith Brooks, in reaction to this mechanism, was frequently heard to remark, "Yes, my mind may be but the rattle of machinery, but what perplexes me is who hears the rattle?"

To modern physicists, the mechanism that prevailed three decades ago no longer appears to be satisfactory. Millikan closed his presidential address at Cleveland, last December, with the question "Has not modern physics thrown mechanism, root and branch, from its house?" and Jeans has placed a Creator back upon the throne. He says: "Everything points with overwhelming force to a definite event, or series of events of creation. . . . The universe can not have originated by chance out of its present ingredients."

Modern biologists are yet striving to reduce vital phenomena to mechanical terms. Surface phenomena, colloidal phases and molecular changes are invoked, and that properly so, to explain these phenomena. But we must keep in mind that vital phenomena carry us beyond the ponderable. So our scientific efforts will not suffice when we come to consider all that life displays. Even an ameba carries us beyond the realm of science. Men have sought to explain the movement of this unicellular animal as the result of surface tension disturbances, of changes in colloidal states or of molecular changes. An

[1] Address delivered at the Virginia Academy of Science, April 24, 1931.

analogy is seen between an ameba's rejection or ingestion of food and the rejection or acceptance of a glass filament by a drop of chloroform. If the filament be naked the filament will be rejected, but if it be coated with shellac it will be taken into the drop of chloroform in a manner that suggests an ameba's ingesting an algal filament. The movement of an ameba and the factors determining whether food and non-food be accepted or rejected are all proper subjects for scientific investigation. Some day I expect these phenomena to be reduced to physical and chemical terms. Science has not yet explained the manner in which the muscles of man contract. I expect that the contraction of the muscles of man will be reduced to physical and chemical terms in time. Both the ameba and man, however, carry one beyond the limitations of science in their respective activities. When a man seeks to lay hold of a non-motile object he approaches it directly. A man seeking to lift a fountain pen, for example, does so directly. When, however, he attempts to lay hold of an animal that may escape, his approach is indirect and he endeavors to meet the contingency of escape. The ability of man to so move in order that he may meet the contingency of escape on the part of an animal is fraught with the idea of teleology or purpose. Science, as such, can not deal with teleology and purpose, but biology may have to do so.

With the aid of my students I have been able to observe that an ameba is very much like man in this respect. Ameba's food-reactions fall into two categories. When an ameba encounters a food-object—plant or animal—that is non-motile its reaction is direct. It intimately surrounds the object. When, however, a motile object of prey is encountered, the reaction may be quite varied and is always indirect. If, for example, the ameba encounters a quiet chilomonas or paramecium it will surround it with a wide embrace and cut off all lines of escape before the prey is disturbed. So varied and so frequent have been the reactions of this type that we have observed in our laboratory, that I am prepared to make the significant statement that the unicellular animal, *Amoeba proteus,* meets contingencies. This fact carries us beyond science, whether we like it or not.

These observations stand in contrast to the observations of a southern anatomist, who was in the habit of telling his auditors that he had dissected many human bodies and had never found a soul. Over against this I may remark that I have studied many amebas and have never failed to find more in them than that that occupied space, namely, the ability to meet contingencies.

All living things present this apparent teleology. It is because of this that biologists must so frequently use the phrase "in order that." Physicists and chemists can get along with the phrase "as a result of."

The physicists tell us that sand collects in an eddy as a result of the forces that are playing upon it; but a biologist sees that a shelled ameba (*Difflugia*) collects sand in order that its child may have microscopic stones with which to build its house.

Sticks and straws drift before the wind as a result of the energy exerted by the currents of air; but a robin collects sticks and straws in order that it may establish a home for its nestlings.

The moon shines as a result of the sun's light being reflected; but youths go out into the moonshine in order that ————!

All this implies a teleology or a purposiveness that even the mechanists can not get away from; for examine the biological writings of the most ardent mechanist and see how frequently one encounters the phrase "in order that" and how earnestly he writes in order that he may carry conviction.

But I shall not be content with citing the fact that a subtle teleology creeps into the writings and efforts of biologists who would avoid it. I have made some very significant observations, in this respect, upon a small turbellarian worm known as microstomum. It has been found that this animal eats hydrae primarily for the "stingers" (nematocysts) of the latter. A microstomum lacking "stingers" readily eats hydrae. Microstoma loaded with "stingers" will only with difficulty be made to eat hydrae. In this case, however, the "stingers" will be regurgitated. It has been demonstrated that the "stingers" of hydrae are actually used by the microstomum that had appropriated them. Perhaps the most significant feature of microstomum's ability to handle the "stingers" of hydrae is that it persists. Microstoma have been reared 22 asexual generations away from hydrae. Had all the individuals of these 22 generations been kept there would have been a population of 2,096,752 individuals. Only one of these potential animals was chosen for observation. This one had now been removed by 21 generations from experience with hydrae and its "stingers." And yet it ate a hydra and appropriated its nematocysts. Another line was maintained away from hydrae for 16 generations. Had all the individuals of these 16 generations been kept, there would have resulted a population of 32,768 individuals. One of this potential population was selected for experimentation. Its middle third was cut out and cared for. The anterior and posterior thirds were rejected. In time, the middle third had developed a new head and a complete body. The

resulting animal thus had a new central nervous system and had been removed from experience with hydrae by 15 generations. And yet it accepted a hydra and appropriated the nematocysts or "stingers."

This research has convinced me that life persists and is purposive.

Were I to have made this claim fifteen years ago, I should have had difficulty finding support in biological literature.

But times have changed. There appears to be a drift away from mechanism in modern biological thought. Haldane gives "freedom of the will" as one of four factors of evolution. Jennings says, "Emergent evolution does away with that monstrous absurdity that has so long been a reproach to biological science; the doctrine that ideas, ideals, purposes have no effect on behavior." Wells, Huxley and Wells, in "The Science of Life," record that, "Human purpose is one of the achievements of evolution" and that "Modern biology is steadily moving towards the conception of a single world-stuff with both material and mental aspects."

In modern biological thought, therefore, purposiveness is coming to be recognized. Mind is no longer the clatter of machinery but an entity placed upon a par with matter. Less is heard these days of the cerebral cells secreting thoughts as the liver secretes bile than was the case twenty years ago. Biologists may come to realize that mind (life) is an entity with which they must deal as do physicists and chemists deal with matter. They may come to agree with Jeans when he says, "To-day there is a wide measure of agreement, approaching almost to unanimity, that the stream of knowledge is leading towards a non-mechanical reality; the universe begins to look more like a great thought than like a great machine."

The cosmic test-tube of the mechanists seems to have boiled over, and we find the purposiveness of Aristotle threatening to displace the mechanist's idea of chance survival.

SCIENTIFIC EVENTS

THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

LORD RUTHERFORD opened the new headquarters of the British Non-Ferrous Metals Research Association in London on June 8, near Euston Station. The building provides space for the collection of machinery to assist the staff in carrying out its work. The following summary of his address is given in the London *Times:*

The quantity and quality of the work of the association in the past ten years, Lord Rutherford said, were surprising when the early difficulties of the organization were considered. It seemed to him that in future they must divide the work of the association under three categories: (1) *ad hoc* researches or special investigations bearing on the difficulties of the industry at a particular moment, which might help to improve a product or get over some technical difficulty; (2) long-range fundamental research bearing on matters that lay at the foundation of the industry; and (3), finally, the steady accumulation of knowledge that would lead to the creation of new industries or the development of existing ones. An association of that kind could not take short views.

Referring to the need for close liaison between scientific men and industrialists, Lord Rutherford noted how much had been done by the association to simplify the results achieved by research to the industrial mind. He regarded this as an important matter, because it restricted the inevitable time lag that occurred between scientific discovery and its use in industry. In estimating the results of scientific research there was always a danger of taking too narrow a view of the work. They could not expect in research work a certain definite return every month. One of the marvels of the age was the development of the motor-car since 1900, on which tens of thousands of men were engaged to-day and for which special steels, special alloys and many other materials were required, each of them representing a great deal of research work. Of the 60 or 70 metals available for research only six or seven had been investigated by the association. What about the other 60? It was obvious that an enormous amount of work remained to be done.

There was probably not a single process that was going on in the industrial world that would not be capable of improvement if it were studied scientifically. He was quite sure that 90 per cent. of the processes used in industry could be improved by the application of science. In the new building there would be no lack of work in research for years to come, even if they multiplied the staff 10 to 20 times. The future of the metal industry, as of many others, was ultimately dependent on the application of science to industry. He thought that in the years to come only those industries would survive in the world which had shown their power of applying scientific knowledge to improve their methods of production.

RESEARCH RESERVES IN THE NATIONAL PARKS

A DEFINITE policy of preserving research reserves inside national park areas has been adopted by the National Park Service. The national parks themselves are areas preserved in as nearly as possible

their natural condition for the use of the people. The research reserves, however, carry the preservation a step farther, for in them it is proposed to maintain conditions unmodified and free from external influences of any sort, in order that their geologic and biologic exhibits may continue to be available in primitive form for the purposes of education and scientific investigation.

The research areas will not be approached by roads or trails, and will be located in isolated sections of the national parks where they will neither interfere with the administration of the parks nor with park use by the public.

Admission to these special areas, whose location will not be announced generally, will be by special permission only, and then only for the purpose of making scientific studies or in connection with the administration of the tract. The wild animals and plants in these perpetual reserves will be left absolutely unrestricted unless some invasion from the outside should seriously disturb the natural balance.

The idea of having these special research areas inside the national parks is not new, as the first one was established in the Yosemite National Park, California, in 1926. Another was established in Mount Rainier National Park, Washington, in 1928. While further reserves of this nature have been planned for several years, actual designation has awaited the formation of a definite policy in the matter and the making of the necessary field examinations and studies.

SUMMER WORK OF MEMBERS OF THE DIVISION OF GEOLOGY OF HARVARD UNIVERSITY

The Harvard Alumni Bulletin gives the following account of work planned for the summer by members of the Division of Geology:

Professor Percy Raymond will give a large part of the coming summer to the study of fossil crustaceans in museums of England, Scotland and Ireland. He sailed for England last month.

Professor R. DeC. Ward plans a short trip to several of the smaller islands of the West Indies in order to obtain first-hand information concerning their weather and climate. This "field-work" will be undertaken in connection with the writing of the chapters on the climatology of the United States, Mexico and the West Indies for the new Köppen-Geiger "Handbuch der Klimatologie." Professor Ward will be in Cambridge during the rest of the summer, writing his book on "The Principles of Climatology."

Russell Gibson, instructor in geology, will spend the summer in northwestern Montana, where he will examine mines and prospects and map a geology for the U. S. Geological Survey.

L. Don Leet, instructor in seismology, will devote the entire summer to the determination of the velocity of seismic waves in granite at Quincy, Massachusetts, and Westerly, Rhode Island, by recording on portable seismographs the vibrations set up by dynamite explosions.

Professor Kirtley Mather also will give some time to the geophysical research on the Quincy and Westerly granites, which is being carried on with the aid of a grant from the Milton Fund. Except for a few weeks' vacation on Mt. Desert Island, he will be at work during the rest of the summer on his new book entitled "South America, the Land and Its Resources."

Professor L. C. Graton will go to Canada early this month and continue his investigations of the geology of the ore deposits at the Hollinger mine, Porcupine, Ontario, and at the mines of the International Nickel Co., near Sudbury. Later in the summer, he expects to spend some time at the Hercules mine near Wallace, Idaho, and to visit a number of other western mining districts before returning to Cambridge.

Professor Donald H. McLaughlin will continue his geological work for the Homestake Mining Co. during the summer. Underground work at the company's large gold mine in the Black Hills of South Dakota will take six weeks or so, and a few additional weeks will be spent on mine examinations in Canada and in California. He will devote a few weeks to field work in the Tayoltita and Guanacevi districts in Mexico, where geological investigations are under way.

Professor Marland P. Billings will be on the staff of the U. S. Geological Survey during the summer. He will continue his work in the Rocky Mountains.

Professor Kirk Bryan will be in charge of the Harvard Summer School in the Jemez Mountains, New Mexico, from June 29 to August 8. He will spend the rest of the summer in the study of the physiography of the Rio Grande Valley (an investigation supported by the Shaler Memorial Fund) and somewhat later will prepare plans for an excursion for the International Geological Conference of 1933.

Professor Esper S. Larsen is at work in the field in California and will continue throughout the summer.

Professor D. S. Whittlesey expects to spend the whole summer in Europe, gathering material for a book he is preparing on economic geography. He plans to attend the International Geographical Congress in Paris, at which he will present a paper.

Harold S. Kemp, instructor in geography, will collect material throughout Central Europe, particularly in the Balkan States, to be used in the forthcoming "Geography of Europe," on which Professor Blanchard and he are working.

THE DEDICATION OF LAKESIDE HOSPITAL AT WESTERN RESERVE UNIVERSITY

THE formal dedication of the Lakeside Hospital group on June 17 brought to completion the Western Reserve Medical Center, on which the sum of $15,000,000 has been expended.

From all sections of the country delegates of the leading scientific, medical, educational, social and civic organizations came to attend the ceremonies and pay tribute to the institution.

Representing the latest in architecture, design and equipment, Lakeside Hospital and its affiliated institutions are models of modern hospitalization. The Western Reserve University medical group is comprised of (in addition to the Lakeside group containing Lakeside Hospital and the Mather, Robb, Lowman and Harvey Houses, nurses' and physicians' quarters, and Hanna House, the private patients pavilion) the Schools of Medicine, Dentistry, Pharmacy and Nursing, Babies' and Children's Hospital, Maternity Hospital, the Institute of Pathology, Rainbow Hospital and the Power House and Service Building.

As a constant benefactor of the university and its great medical center, and one who for nearly half a century has been the chairman of the Lakeside Hospital Board, an illuminated appreciation was presented to Mr. Mather who presided at the dedication.

The address of dedication was delivered by Dr. Hans Zinsser, professor of bacteriology in the Harvard Medical School. Upon him Western Reserve University conferred the honorary degree of doctor of science.

The degree was also conferred on Dr. Samuel Clark Harvey, professor of surgery, Yale University School of Medicine; Dr. Evart A. Graham, professor of surgery, Washington University School of Medicine; Dr. Alphonse Raymond Dochez, professor of medicine, College of Physicians and Surgeons, Columbia University; Dr. David Marine, director of laboratories, Montefiore Hospital and assistant professor of pathology, College of Physicians and Surgeons, Columbia University, and Dr. Alfred Newton Richards, pro fessor of pharmacology, University of Pennsylvania School of Medicine.

The doctorate of laws was conferred on Dr. Henry Asbury Christian, Hersey professor of the theory and practice of physic, Harvard University Medical School, and on Dr. James Ewing, professor of pathology, Cornell University Medical College.

BRITISH BIRTHDAY HONORS

THE Birthday Honors List of King George, as reported in *Nature,* contains the names of the following men of science and others associated with scientific work: *Order of Merit:* Sir William Bragg, in recognition of his eminent services in the advancement of science. *Knights:* Dr. J. B. Baillie, vice-chancellor, University of Leeds; Colonel S. R. Christophers, director, Central Research Institute, Kasauli; Dr. W. C. D. Dampier-Whetham, fellow of Trinity College, Cambridge; Dr. P. C. Varrier-Jones, founder and medical director of Papworth Village Settlement for the Treatment of Tuberculosis; Professor S. R. Krishnan, King George V. professor of philosophy, University of Calcutta; Professor H. Lamb, emeritus professor of mathematics in the University of Manchester; Mr. C. R. Peers, president of the Royal Society of Antiquaries; Mr. R. L. Robinson, vice-chairman and technical commissioner of the Forestry Commission. *C.I.E.:* Dr. L. C. Coleman, director of agriculture, Mysore State; Mr. A. McKerral, director of agriculture, Burma; Mr. C. A. Malcolm, chief conservator of forests, Central Provinces, India. *C.B.E.:* Dr. Kate Barratt, principal of Swanley Horticultural College, Kent; Mr. W. J. Hadfield, city engineer and surveyor, Sheffield, a pioneer in modern developments of highway engineering and road surfacing; Professor H. M. Hallsworth, David Dale professor of economics, Armstrong College, University of Durham; Dr. Alice Werner, lately professor of Bantu languages at the School of Oriental Studies, London. *I.S.O.:* Mr. W. H. Moorby, assistant civil engineer-in-chief, Admiralty; Mr. J. B. Scrivenor, director of the Geological Survey, Federated Malay States.

SCIENTIFIC NOTES AND NEWS

THE doctorate of science was conferred by Harvard University at commencement on Dr. Harvey Cushing, Moseley professor of surgery. In conferring the degree President Lowell said: "Adroit with both the scalpel and the pen, a charming writer and the most renowned cerebral surgeon in the world."

AT the commencement exercises of the Massachusetts State College, the honorary degree of doctor of science was conferred on Dr. Charles S. Howe, formerly president of the Case School of Applied Science, Cleveland, and on Dr. Joseph L. Hills, dean of the College of Agriculture of the University of Vermont.

THE doctorate of science of Bowdoin College was conferred on June 18 on Dr. Isaiah Bowman, director of the American Geographical Society, New York.

AT Dartmouth College the degree of doctor of science was bestowed on Dr. William Patten, professor of zoology at the college, who retires this year after serving for forty years, and on Dr. Lawrason Brown, of Saranac Lake, New York, specialist in the treatment of tuberculosis.

DR. HERBERT V. NEAL, professor of zoology and dean of the Graduate School of Tufts College, has received the doctorate of science from Bates College.

THE degree of doctor of science was conferred at the Yale University commencement on Dr. Eugene Lindsay Opie, professor of pathology and head of the department at the University of Pennsylvania and director of the Henry Phipps Institute, Philadelphia, and on Dr. John Ripley Freeman, of Providence, Rhode Island, civil engineer.

DR. BERTHOLD LAUFER, a member of the staff of the Field Museum for the past twenty-three years, was awarded the degree of doctor of laws at the one hundred and sixty-fourth convocation of the University of Chicago. The citation of Dr. Laufer was "in recognition of his distinguished service to science as curator of anthropology in the Field Museum of Natural History and especially of his scholarly and illuminating contributions to the study of the archeology, ethnology and philology of Asia."

WESLEYAN UNIVERSITY conferred the doctorate of science on Dr. Raymond Dodge, of Yale University, formerly professor of psychology at the university, and on Dr. Albert Francis Blakeslee, of the Carnegie Station for Experimental Biology (Wesleyan, 1896). President McConaughy pronounced the following characterizations as the degrees were conferred: On Professor Dodge: "Internationally known for your exact experimental work, largely responsible for Wesleyan's eminence in psychology, after twenty-six years here we lent you to Yale for leadership in her Psychological Institute and the Institute of Human Relations." On Dr. Blakeslee: "Trained by Professor Conn, scientific investigator in Europe and South America, leader of the work in biology and genetics at the Carnegie Station for Experimental Biology, president of the American Society of Naturalists."

DR. IRVING LANGMUIR, of the General Electric Company, has been elected an honorary member of the German Chemical Society, Berlin.

DR. EDWARD B. STEPHENSON, physicist in the sound division of the Naval Research Laboratory, Bellevue, Washington, D. C., was recently awarded a cash bonus of $2,000 by the Navy Department for his contributions to the technique of preparing quartz crystals for use in controlling the frequency of radio transmitters.

DR. ALBERT RUSSELL MANN, dean of the New York State Colleges of Agriculture and Home Economics at Cornell University, will resign these offices to become provost of the university, a newly established position designed to relieve the pressure on the office of the president.

DR. ALFRED STENGEL, a past president of the American College of Physicians, has been appointed vice-president for medical affairs at the University of Pennsylvania.

DR. RALPH W. CHANEY has been appointed professor and chairman of the department of paleontology at the University of California. The appointment takes effect on July 1. Dr. Chaney will assume the position which was for many years held by Dr. John C. Merriam, now president of the Carnegie Institution, and more recently by William Diller Matthew, whose death occurred on September 24. He will continue his research relationship with the division of plant biology of the Carnegie Institution of Washington.

DR. FREDERICK C. LEONARD, of the University of California at Los Angeles since 1922, has been appointed chairman of the newly created department of astronomy.

DR. ROYAL N. CHAPMAN has been appointed dean of the newly organized Graduate School of Tropical Agriculture at the University of Hawaii. The new school will have library, research and laboratory facilities with an estimated value of a million dollars, as the result of an agreement to pool the resources of the University of Hawaii, the Bishop Museum and the Experiment Stations of the Hawaiian Sugar Planters Association and of the Association of Hawaiian Pineapple Canners. Instruction will be given in the sciences fundamental to tropical agriculture. The faculty includes Dr. Oscar N. Allen, Dr. Leonora N. Bilger, Dr. Walter Carter, Dr. Julius L. Collins, Dr. Francis E. Hance, Dr. Maurice B. Linford, Dr. Harold L. Lyon, Dr. Oscar C. Magistad, Dr. Albert J. Mangelsdorf, Dr. Christos P. Sideris, Dr. Harold St. John, Cyril E. Pemberton, Otto H. Swezey and Harold A. Wadsworth.

IT is announced in the *Scottish Geographical Magazine* that as from October next Mr. A. G. Ogilvie, at present reader in geography in the University of Edinburgh and joint honorary secretary of the Royal Scottish Geographical Society, will become professor of geography. This is the first professorship in geography to be established in a Scottish university, and represents the culmination of long-continued efforts on the part of the Royal Scottish Geographical Society.

AT the annual meeting of the American Society for Pharmacology and Experimental Therapeutics, Professor George B. Wallace was elected *president* and Professor Velyien E. Henderson, of the University of Toronto, *secretary*. In accordance with the constitution of the Federation of American Societies for Experimental Biology, these two officers become the

president and secretary of the federation for the year 1931–32.

DR. JOHN L. MORSE, of Boston, was elected president of the American Society of Pediatrics at the closing session of the first annual meeting at Atlantic City.

MR. JULIUS DANIELS, assistant superintendent of the promotion department of the Edison Electric Illuminating Company, has been elected president of the Illuminating Engineering Society.

AT the annual meeting of the British Optical Society on May 14, Professor A. O. Rankine was elected to the presidency.

OFFICERS of the Royal Society of South Africa have been elected as follows: *President,* Dr. W. A. Jolly; *Honorary treasurer,* Dr. L. Crawford; *Honorary general secretary,* Dr. B. F. J. Schonland. Resolutions were passed at the recent annual meeting to protest against the recent reduction of the government grant to the society.

DR. E. V. MCCOLLUM, of the Johns Hopkins University, and Dr. Harry Steenbock, of the University of Wisconsin, will be delegates from the United States at a meeting called by the League of Nations to advise on methods for the standardization of vitamins.

DR. PORTER J. CRAWFORD, a field director of the International Health Division of the Rockefeller Foundation, who at present is directing the yellow fever campaign in Para, Brazil, has leave of absence which he expects to spend in the United States.

DR. JUNIUS HENDERSON, professor of natural history and curator of the museum of the University of Colorado, and Mrs. Henderson, have left for California, where they will spend the summer collecting mollusks.

A SCIENTIFIC expedition from Harvard University to Australia under the auspices of the Harvard Museum of Comparative Zoology and under the leadership of Professor William Morton Wheeler will leave New York on July 25 to make a study and collection of its fauna. Other members of the expedition include Dr. Glover M. Allen, associate professor of zoology and curator of mammals at the museum; Dr. Ira M. Dixson, medical officer of the expedition, and P. J. Darlington, Ralph Ellis and William Schevill, graduate research workers.

DR. E. T. WHERRY, professor of botany at the University of Pennsylvania, and Dr. F. W. Pennell, of the Academy of Natural Sciences of Philadelphia, have left for Council Bluffs and will spend the next three months in the field, in an effort to rediscover the places where early botanists first found many of the species of plants common to the West.

PROFESSOR WILLIAM MCDOUGALL, of Duke University, delivered the Ludwig Mond lecture at the University of Manchester on May 19.

DR. HARRY WALDO NORRIS gave the commencement address at Grinnell College on June 8, in commemoration of his forty years of teaching service as professor of zoology in that institution. Dr. Norris continues his connection with Grinnell College under the title of research professor of zoology.

THE Thomas Young Oration of the British Optical Society was delivered at the College of Science and Technology, South Kensington, on June 11, by Sir John Parsons, who spoke on "Young's Theory of Color Vision."

THE China Foundation with headquarters at Peiping has announced special research awards for the year 1931 to the following: Ren-chang Ching, authority on Chinese ferns, who is continuing work in the leading herbaria of Europe; Ching-yueh Chang, for his work on root anatomy. Te-pang Hou, Ph.D., chemical engineer of Tientsin, who is responsible for the first ammonia-soda plant to be established in the Far East; Chi-kung Jen, physicist, for work on the electron tube oscillator, and Hsien-wen Wu, zoologist, for his work on the fish fauna of South China. In addition to the above, the foundation has awarded twenty fellowships to Chinese research workers for special training abroad and has made a like number of fellowship grants for the support of research work at scientific centers in China. These awards are made by an advisory committee of scientific workers resident in China. This foundation was established in 1923 on the funds of the Boxer Indemnity returned to China by the United States government. Of the foundation's annual appropriations, about $100,000 is devoted to research professorships and to the encouragement of scientific research.

MR. CYRUS H. K. CURTIS has made an unrestricted gift of $1,000,000 to the University of Pennsylvania.

BY the will of the late O. M. Eidlitz public institutions receive direct bequests and remainder interests amounting to more than $750,000. These include $229,576 to the Presbyterian Hospital; $153,050 to the Roosevelt Hospital, and $54,666 each to the Hospital for the Ruptured and Crippled, Fifth Avenue Hospital, Manhattan Eye and Ear Hospital. Cornell University receives $25,000 for a scholarship in the engineering department.

THE Soil Fertility Conference at the Pennsylvania State College, held in commemoration of the founding of soil fertility experiments at the college in 1881, opened on June 24. The speakers included F. D.

Gardner, C. F. Noll, J. W. White, A. L. Patrick, F. G. Merkle, F. J. Holben, C. D. Jeffries, all of the staff of the agronomy department, and Walter Thomas, plant chemist of the college; C. F. Marbut, U. S. Bureau of Chemistry and Soils; C. E. Thorne, formerly director of the Ohio Agricultural Experiment Station; A. B. Beaumont, Massachusetts Agricultural College; S. A. Waksman, New Jersey Agricultural Experiment Station; Richard Bradfield, the Ohio State University; J. A. Bizzell, Cornell University; Emil Truog, University of Wisconsin, and S. D. Conner, Indiana Agricultural Experiment Station; H. G. Knight, chief of the U. S. Bureau of Chemistry and Soils; J. G. Lipman, director of the New Jersey Agricultural Experiment Station; J. G. Patterson, director of the Maryland Agricultural Experiment Station; Enos H. Hess, president of Messiah Bible College, Grantham, Pennsylvania, and Frank M. Swartz, geologist at the college. Field trips were taken over the 144 plots in the 50-year-old experiment and an auto tour was arranged to Snow Shoe and Kylertown to observe experiments there. There was a reception to guests, and a banquet with Dean R. L. Watts, of the School of Agriculture, as toastmaster.

SIGMA GAMMA EPSILON, the national honorary geological fraternity, has accepted the petition of the Geological Society of Texas Technological College, and eighteen members of the group were recently initiated as charter members of the college's chapter of the fraternity.

AN economic and social survey of the southern Appalachian region, recommended by numerous public and private educational institutions, will be started this summer. The Bureau of Agricultural Economics will cooperate with the Bureau of Home Economics and Forest Service of the Department of Agriculture, the Office of Education, and several state experiment stations.

THE Royal Society of Canada at its recent convention in Toronto passed a resolution to the effect that Canada should establish three or four magnetic stations in the far north this year, while a dozen more should be established in other northern countries. One of the stations will probably be in northern Labrador, another north of Churchill, and a third at the mouth of the Mackenzie River. Each station will be manned by three to five men, with an expert meteorologist and physicist in charge.

The Geographical Journal, London, reports that, according to a statement made at the second annual meeting of the Canadian Geographical Society by the president, Dr. Charles Camsell, the society now has 29,801 members. The organization was completed in the middle of 1929, and the society became active about the end of that year. Thus nearly 30,000 members have been enlisted in little over twelve months. The first issue of the *Canadian Geographical Journal* appeared in May, 1930, when 10,500 copies were printed; there was a subsequent reprint of 3,000 additional copies to meet the unexpected demand. 35,000 copies of the January, 1931, issue were printed for distribution to the society's members throughout Canada, Great Britain, the United States and elsewhere, the circulation covering no less than thirty-two foreign countries. The society's principal object is to disseminate knowledge of Canada's geography, resources, industrial development and economic possibilities.

The Experiment Station Record reports that the International Institute of Agriculture announces that a prize of 10,000 lire will be awarded annually for the best work on agricultural economics from a fund constituted in honor of the recent marriage of the Crown Prince of Italy and Princess Marie José of Belgium. The closing date for the submission of material for the first year is September 30, 1931, and the prize will be awarded on December 31. Participation will be restricted to works published within the two preceding years by authors belonging to countries adhering to the institute. The adjudication will be in the hands of a jury of five, consisting of the president of the institute and four members nominated by the permanent committee in such a way as to represent five different nations. Copies of the regulations and further information may be obtained from the president of the institute at Rome.

THE council of the senate of the University of Cambridge has made a long report to the university on John Humphrey Plummer professorships. It had been originally estimated that the income to the university from this source might be £10,000 a year. Since the time of Mr. Plummer's death the value of his estate has decreased. The council now consider that an annual income of £5,000 is a reasonably safe figure to take. The proposals which the council now lay before the university involve an annual expenditure of £4,260, and it is understood that the trustees would agree to this sum. The council accordingly has recommended "That the council of the senate be authorized to inform the Plummer trustees that the university would approve of the establishment in the university on the John Humphrey Plummer Foundation of professorships of inorganic chemistry, of mathematical physics and of colloid science, and of an annual payment at the initial rate of £300 from the Plummer Fund towards the maintenance of the department of colloid science."

The Experiment Station Record reports that an Agricultural Research Institute of Rumania was established under a law enacted in 1927 and formally organized in 1929. It now contains sections of phytotechny and phytogenetics, chemistry, phytopathology and rural economics, and it is expected that these will be supplemented with sections on animal production and rural engineering. It has also taken under its direction the Central Agronomic Station at Bucharest; the agricultural chemistry, agricultural technology, seed control, and medicinal plants stations at Cluj; the phytopathology station at Chisinău; the newly established machinery testing station at Bucharest; the agricultural plant improvement and experiment stations at Jassy and Cluj, and agricultural experiment stations at Mărculesti and Tighina.

VISITORS from twenty-one foreign countries registered at the Petrified Forest National Monument in Arizona during the month of April, according to an announcement made by the Director of the National Park Service of the Department of the Interior. The countries represented were: Australia, Austria, Canada, Czecho-Slovakia, Denmark, England, France, Germany, India, Indo-China, Ireland, Italy, Japan, New Zealand, Norway, Poland, Singapore, Spain, Sweden, Switzerland and Venezuela. Visitors from every state in the union and from the District of Columbia also registered at the monument. The Petrified Forest National Monument is an eroded deposit of petrified logs said by scientists to be nearly two hundred million years old. Many of the petrified tree trunks found in the area are more than 100 feet in length. The indications are that some of these trees must originally have attained a height of more than 200 feet. Many interesting features of this ancient deposit of great tree trunks, cross sections of which reveal every color in the rainbow, have been uncovered by the work of erosion. One petrified log, originally embedded in sandstone, forms a natural bridge, erosion having scooped out a small arroyo under the log. One of the three divisions of the area is called "Rainbow Forest," and chips of agate, onyx, carnelian and jasper are scattered over the ground in every direction.

THE Bird Sanctuary Committee of the Selborne Society, England, has made an urgent appeal for help in safeguarding the Brent Valley Bird Sanctuary, according to a report in the London *Times*. The founding of this reserve, the first of its kind, by the Selborne Society in 1902 set an example which has been widely followed, as the numerous nature reserves now in being attest, and many bird lovers wishing to make small sanctuaries of their gardens have been supplied by the society with boxes like those designed for the Brent Valley Sanctuary. In 1920, the bicentenary year of Gilbert White, of Selborne, the sanctuary was bought as a memorial to the father of British field natural history. The amenities of the Brent Valley Sanctuary will be safeguarded on the north and east by the welcome decision of the Middlesex County Council to keep adjoining fields as an open space. On the west, however, a factory has recently been built. Two fields on the south and south-east are now scheduled as factory sites, and unless the Selborne Society can buy them by June 1 the land will be sold. It is for the purchase of these fields on the south and south-east of the reserve that the Bird Sanctuary Committee is appealing. Most of the land in question, it is stated, could be used for playing fields if some benefactor would come forward in time to save it. For some time past the society has been trying to raise the necessary sum, but it still needs nearly £1,400 to secure the smaller field or £5,000 to secure both. The address of the honorary secretary is The Hermitage, Hanwell, W. 7.

DISCUSSION

EVOLUTION A DETAIL IN THE DYNAMICS OF POPULATIONS

As has already been pointed out,[1] known sorts of organisms are not a representative sample of the world population of species in their respective families and orders. The statement rests upon analysis of the taxonomic record of living Chiroptera, Ophiuroidea, Crinoidea, Decapoda and Cactaceae. The relative constancy of form of the curve of genera plotted by size in such groups permits the extension of the conclusion to the living world in general.

Two facts explain why matters stand as they do. First, the ranges of species of great genera are larger upon the average than those the species of lesser genera occupy. Second, collectors are impressed by the novelty of species of the smallest genera and, when working in the field, spare no effort to secure specimens.

As a result, in groups where the prevailing method of collection is mechanical, as it is when tow-net, dredge or trawl is employed, the greater genera are over-represented in the haul. But, in groups where the collector's psychology determines in part what shall be turned in for study and naming, genera least and greatest in size are both over-represented; and

[1] SCIENCE, lxxii, 1858, 141, August 8, 1930; *Anat. Rec.*, xlvii, 3, 350, December, 1930.

others too large to permit their species to enjoy the one, and too small to allow them to enjoy the other advantage extremes profit by, are under-represented.

When this fact is recognized it becomes plain that the distribution of no peculiarity in the known sample certainly corresponds with its statistical distribution in the grand total of species. But, as the sample moves inevitably toward the total as its limit, all calculated distributions of attributes in it move toward actual distributions in the whole as their respective limits.

Now upon investigation it appears that the limiting form of the curve of genera plotted by the number of their species is a function of the normal curve. Pursuing this clue one finds that in all large natural groups of organisms, with whatever ability to maintain itself in the world the family or ordinal ancestor may have been endowed, the living species sprung from it have normal frequency distribution of the like ability. It is determinable also that though the species of small genera have on the average, when world population is considered, less ability than those of greater, in all local faunas and floras groups of species assorted by world size, or by local size of the genera to which they belong, have the same average ability to spread.

In the relations existing within systems of species one thus discovers the equivalents of dynamic relations holding within systems of molecules free to move. Both sorts of system show a tendency to attain a "normal state," to which they are bound to return after whatever disturbance. In each, for a given energy content, there is a single normal state attainable. In molecular systems in the normal state there is normal frequency distribution of component velocities along each of the three axes with respect to which actual velocities are conventionally resolved. Finally, in the inorganic system and the systems of species compared with it there is equipartition of energy among the different capacities to receive it.

This means that all that interplay of action and reaction which occurs between species and species, and between species and environment, and passes as a whole under the name of "struggle for existence," proceeds with an order as definitely predictable in its outcome as that manifested in a gaseous system under the terms of kinetic theory.

A kinetic theory of species is, indeed, as completely justified as a kinetic theory of gases, but before proceeding further we must for a moment consider a related matter, the mode of growth of populations.

As Pearl and Reed,[2] and Pearl and others have shown, the process, whether in cultures of yeast and bacteria or in human populations, follows one law. This may be stated as follows:

In an environment of which the limited resources are constantly renewed every population tends momentarily to be augmented by a fraction which diminishes as the attained fraction of the limiting population increases.

But populations may not increase so, unless they are in fact as sensitive to fractional increases in population pressure as the formula requires. It is astounding, but a fact, nevertheless, that the measure of difficulty the generation of 1790 had in rearing its children in America should have gauged accurately the ultimate and largely unutilized resources of so great a country. Each later generation, however, so far confirms the ancestral experience.

The only factor of known power to modify the curve of a population's growth effectively is the exhaustion of resources, as Pearl has shown in experimental cultures of Drosophila, or the utilization of new resources, as when a population turns rather abruptly from agriculture to industry for its support. In either case a new maximum is set for the limiting population against which fractional increases are measured. That is all.

It is a fact of profound significance that the curve of population growth in the United States is unaffected permanently by the varying rate of immigration. From census to census the effect is *nil*. When a nation's resources permit a definite increase in the number of its people in a prospective unit of time, that increase and no more tends to be attained, whether or not the resident population be augmented in any degree by immigration.

In a mixed population the pressure equals the sum of the partial pressures, and the increase in pressure in the total population as it grows is equal to the sum of the increases in the partial pressures of its several components.

To say that the slope of the curve of population growth is a function of the limiting population, and has nothing to do with immigration, is simply to put the same fact in other terms. The steeply rising curves of population of the United States and of Russia, as contrasted with other less favored regions, merely reflect the richness of those countries' resources.

The effect of the law of partial pressures is evidenced again in the negative correlation between death-rate and birth-rate.[3]

Now grant molecules of any gas at zero pressure the power of producing others like themselves at a

[2] See Raymond Pearl, "Biology of Population Growth," Knopf, 1925.

[3] G. Udny Yule, *J. Roy. Statistical Soc.*, lxxxviii, January, 1925.

rate determined by their inherent energy only. Let the power of increase fail by the attained fraction of a limiting pressure fixed in the beginning. Then the increasing number of molecules plotted against time will follow the logistic curve. And the addition of molecules from without, or arbitrary changes in the limiting pressure, will induce just such changes in the form of the curve as are registered by actual populations comparably treated. So we see why the growth of populations, human populations included, is subject to laws as little varying and in kind scarcely differing from the gas laws. Populations are simply more complex kinetic systems than physics usually deals with.

Large groups of species related by descent are kinetic systems even more complex than simple populations. They are populations of populations. Species are their elements. These elements are endowed with inherent energy and react with one another at haphazard in an ever-changing environment. The dependence of their mutual adjustments upon the law of chance is revealed in every detail of the equilibrium they momentarily maintain.

In gases, then—simple populations of organisms and populations of the second order—we have a series or hierarchy of kinetic systems of increasing complexity. The gas laws are the characteristic laws of the simplest of the three. The law of population growth expressed by the logistic curve is the new and distinctive law of the intermediate system. But the analogues of the laws of the lower system are inherent in this distinctive law of the higher. We may read them off by inspection:

The population pressure within a group of fixed size varies inversely with the volume it occupies in a uniform medium capable of affording support to a limiting population of definite size per unit volume.

In a uniform medium in which the diffusion of a particular sort of organism is rapid in comparison with its rate of reproduction, while the limiting population remains the same, equal volumes under the same population pressure include the same number of individuals.

The analogy between these and the gas laws they respectively suggest is due to the fact that the simplest gaseous systems and simple populations are each composed of elements of one sort, inherently energetic and attaining a stable state through the play of energy upon energy under the law of chance. That the higher system possesses its distinctive law is due to the fact that its units have one property or capacity significantly different from those of units of the lower. This is their capacity for multiplication at a te dependent upon the attained fraction of the limg population.

As the analogues of the gas laws are inherent in the law of the logistic curve, it remains to say that the law of the logistic is itself inherent in the law of evolution expressed graphically by the function of the normal curve so often mentioned. It is the power the new unit, the species, possesses—of variation for better or worse—which makes the new system with its new law possible. But with the new law of the highest system the laws, or analogues of the laws, of the lower prevail too. So in a very real sense evolution, stupendous phenomenon as it is, is a detail in the dynamics of second-order populations.

W. H. LONGLEY

GOUCHER COLLEGE

NECESSITY OF ORGANIC MATTER FOR THE MAINTENANCE OF AN AVAILABLE SUPPLY OF PHOSPHORUS IN THE SOIL

LABORATORY and field tests of the Louisiana Experiment Station indicate that the greatest problem of the upland soils of the South is of keeping the soil phosphates sufficiently available for the growing of cotton, even with the application of soluble phosphate fertilizers to the soil. It has been found that organic matter is more important from the point of keeping soil phosphates sufficiently soluble for plant growth than from any other point or points. With the depletion of organic matter, the soil phosphates as well as those added become less and less effective. The benefits ascribed to organic matter in the literature are indeed very important, but the rôle of the organic matter in keeping the soil phosphates sufficiently soluble for plant growth overshadows them all.

The problem of keeping the soils of the South in a high state of fertility is one that requires a program of farming that embodies the practice of green manuring in combination with the applications of the required plant foods. In soils depleted of organic matter even heavy applications of soluble phosphates do not have the desired effect. It is only with very heavy applications that a sufficiently high level of available phosphorus is maintained. In soils low in organic matter and high in the sesqui-oxides, the solubility of the phosphates is too low for the maximum growth of plants. It has been suggested that the soluble phosphates be applied in narrow bands to avoid immediate complete reversion, and this practice has given promising results. However, there are still some undesirable features to be worked out in such a practice. The less soluble phosphates, as precipitated tricalcium phosphates, have been suggested, owing to their slower rate of reversion. From a theoretical consideration they should give some promise.

It appears that the full fertilizer value of mineral nitrogen and potassium fertilizers can be obtained in

the absence of organic matter, more nearly so than with phosphorus.

In this connection it is of interest that the successful production of bananas is closely associated with available supply of phosphorus. Bennett's suggestion of pH is only correct in as far as the desirable pH is incidental to a high available supply of phosphorus.

The problem of the South and the Tropics of maintaining the fertility of their soils is one of maintaining a high amount of available phosphorus. The incorporation of organic matter is highly important with a judicious application of mineral plant foods. In other words, the partial and sometimes complete failure of fertilizer, particularly superphosphate, is usually due to lack of organic matter in the soil.

A. H. MEYER

LOUISIANA STATE UNIVERSITY

INSECTS AS POLLEN CARRIERS

Is it an instance of inheritance of acquired characters that we descendants of thrifty Yankee ancestors insist on finding "uses" for various objects in the universe? Nature, viewed by man, is the primary waster, in rather sharp contrast to the exactness with which her work is done. Dr. Frank Lutz, in a recent *Science Service* radio talk, "In Defense of Insects," deplores the method, wasteful and inefficient, of the production of vast quantities of pollen which is never used by anemophilous plants, only an occasional pollen grain finding a logical home. Dr. Lutz seeks to show the usefulness of insects in the economy of man, citing, in his argument, various plants, edible and otherwise serviceable, which depend for their genetic continuity upon insects that bring about cross pollination. Dr. Lutz, no doubt, knows his insects but perhaps he gives them somewhat too much credit for their beneficent attitude toward man so far as cross pollination is concerned. All important vegetable garden plants except corn, he tells us, come, directly or indirectly, from seeds resulting from insect pollination. This includes such plants as lettuce, the tomato, pepper, peas and beans, all of which are known to be self-pollinated, cross pollination by insects being the exception. The three textiles, linen, cotton and wool, are claimed by him as due to insects, the latter only indirectly. As a matter of fact, both the cotton and the flax plant are pollinated only occasionally by insects, depending mainly on their own resources and evidently well able to get along without insects at the present time. As for wool, practical sheepmen are *not* seriously concerned about clover in their pastures and no doubt many of the native legumes are self-fertilized. An important clover in New Zealand, *T. subterraneum,* is non-seed-bearing, while common red clover is not one of the important legumes in the lush New Zealand pastures. Tobacco is another plant specifically mentioned by Dr. Lutz as insect-pollinated, but here again this plant, if it ever depended on insects, has learned to "roll its own"; pollen carrying insects are less its concern than are the aphids which carry its mosaic. Coffee, tea and cocoa plants may be insect-pollinated but judging by the above examples, which have really turned out to be "horrible," perhaps the chances are only even. Dr. Lutz scarcely mentions the part insects might have had in the phylogeny of the higher plants, but his statement that there was no extensive growth of land plants before insects became well established means nothing, except to a teleologist, for the primitive plants of the early land floras, which built the coal measures, could not have depended upon insects for progeny. Perhaps pollen-carrying insects have been important to plants mainly from an evolutionary standpoint and only incidentally do they remain important as accessory to seed production. Plant evolution would have proceeded without insects, but quite certainly the plant world is richer and more complex because of insect cooperation.

L. R. WALDRON

STATE COLLEGE STATION,
FARGO, NORTH DAKOTA

AWARDS FOR SCIENTIFIC RESEARCH BY THE CONGRESS

AT the annual meeting of the Illinois State Academy of Science in Peoria, Ill., on May 8, the president made this statement:

I hope that the time will come when our government will establish not merely medal awards but substantial money prizes to be given annually to Americans who have made the most noteworthy and valuable research contributions and that present limitations on the time of ardent research workers will be removed.

I have reason to believe that a bill establishing such awards will be introduced by an Illinois member at the next session of Congress, and I trust that this organization will be the first to approve it, not from any selfish motive but as a grateful recognition of a great service rendered.

Later in the session, the following resolution was reported by the committee:

Realizing the large value and great importance of research along many lines and the benefits accruing to the people from inventions, explorations and discoveries in science, often the result of patient, persistent and painstaking endeavor,

Resolved, that the Illinois State Academy of Science, while fully appreciating the recognition accorded such work, would respectfully recommend that Congress add

to this the establishment of financial awards for the most noteworthy and valuable inventions and discoveries in the several branches of science, to be bestowed under such conditions as Congress may direct.''

This resolution was unanimously approved.

As a matter of course the present situation with reference to such a measure is purely tentative, until details, if it is thought to be desirable, are worked out.

I have had some correspondence the last three or four months with Colonel B. M. Chiperfield, congressman of the fifteenth Illinois district, on the subject and he wrote that he was favorably impressed. Since the meeting at Peoria he was written as follows:

I think that the measure will require a great deal of careful thought and collaboration on the part of those who are more familiar with the subject than myself. I stand ready to introduce such a measure at any time but I do not feel sufficiently familiar to draft it without considerable assistance.

Of course I do not mean the mere mechanical work of drafting the bill, which is easy enough, but as to what awards should be made, by whom, and for what I shall need advice and direction.

With all that Colonel Chiperfield here says I fully agree. My idea in referring to it at all at the state meeting was based on the belief that ultimately something might be accomplished and that, if the matter were introduced at the next session and referred to a committee of Congress to act with a committee representing the American Association for the Advancement of Science, and the several other organizations of national scope, such as the National Research Council and the National Academy of Sciences, and to prepare the main features of a bill enumerating the number and scope of the awards and the lines for which they were to be made, the material would be in such shape as Colonel Chiperfield suggests.

In the course of a year's study of the development along various lines of research, the prizes bestowed, the fellowships awarded, and medals given, I was impressed with the fact that the most notable of all is a foreign prize, the Nobel, and that the winning of this is a world distinction. There are many generous prizes in our own country, it is true, but they are established largely by individuals, associations and institutions and do not constitute a generous government recognition of a public service. It is true that medals are given and these of course are to be esteemed as tokens of honor and recognition.

I can imagine, however, what an award like the Nobel to the late Albert A. Michelson meant in the prosecution of such a work as he was attempting, if his own means and the limitation on his time would not otherwise have permitted it. It is, indeed, fortunate that we have institutions and museums that promote the work of research, invention, and exploration, and also that we have scientific publications that advance this cause.

But I think also of those with cramped means and limited time, who are engaged in invention, exploration, architecture, physics, astronomy, electricity, chemistry, geology, botany, medicine and surgery, and perhaps other lines of basic research, and who are struggling under adverse conditions to give the people the finished product of their thought and study, whom a government award or endowment or pension might greatly aid and encourage.

Dr. John C. Hessler, a former president of the Illinois State Academy of Science, has suggested that if such a bill is framed it might well include a clause that empowers the government to receive gifts toward such an endowment fund from which awards could be made, and it is possible that there may be many, who, desiring to emulate the example of the founder of the Smithsonian Institution, would gladly be contributors. Such contributors could be added to any appropriation that Congress might make.

But at present it seems to me that Congress at least could, as an initial step, be solicited to appoint a committee to act, as indicated, with a committee of leading scientists.

Personally I believe that such awards in research would inspire and stimulate and result in great good. It is farthest removed from my thought to commercialize science, but rather the idea is to give the best, the freest, the fullest opportunity to the ones most competent to give the world something worth while.

FRED R. JELLIFF,
Past President
ILLINOIS STATE ACADEMY OF SCIENCE

NEW TECHNICAL WORDS

IN the issue of SCIENCE for May 22 (73: 565–566) Messrs. Tester and Bay describe their ingenious instrument, "The shapometer: A device for measuring the shapes of pebbles."

As "shapometer" is an obvious hybrid, interdicted by good usage in fashioning word novelties, and inasmuch as we already have in use the words morphometry and morphometrical, it is hoped that the gentlemen referred to may be induced to adopt the name morphometer for their device (from Greek μορφή, form or shape, + μέτρον, measure). If that term be deemed specifically insufficient, the more definite word psephometer (from Greek ψῆφος, a pebble, + μέτρον, measure) might be suggested.

W. A. DAYTON
U. S. FOREST SERVICE,
WASHINGTON, D. C.

REPORTS

TWELFTH ANNUAL MEETING OF THE AMERICAN GEOPHYSICAL UNION

THE twelfth annual meeting of the American Geophysical Union and the sessions of its sections were held in Washington, D. C., on April 30 and May 1, 1931.

The Sections of Geodesy, Meteorology, Volcanology, Oceanography, Seismology, and Terrestrial Magnetism and Electricity held their meetings April 30. The Section of Hydrology met May 1, and the meeting was concluded with the general assembly of the union on the afternoon of May 1.

Seven papers presented before the Section of Geodesy were devoted largely to progress reports on absolute determination of gravity, Mexican gravity stations, gravity work presented at the Stockholm meeting of the International Union, on graduation and calibration of precision-circles, on the astronomical establishment of points on an unsurveyed boundary in Canada, and on geodetic work during the past year in the United States. Harlan T. Stetson presented also some further investigations of the moon's influence on latitude.

In the Section of Seismology, following the consideration of proposals for the international intercomparison of recently developed types of instruments and study of seismic sea-waves, an interesting series of papers and informal communications was presented, including a paper on the origin of earthquake-waves, progress reports on the development of instruments, the use of precise triangulation and levels in California in seismological investigations, the registration of time-signals, and velocity of explosion-generated longitudinal waves in nepheline syenite. The secretary reported that following the resolution adopted at the eleventh annual meeting a grant had been provided by the Carnegie Institution of Washington, through its Advisory Committee in Seismology, to establish a seismological observatory at the Huancayo Magnetic Observatory in Peru.

At the meeting of the Section of Meteorology the first five papers were concerned chiefly with the International Polar Year proposed for 1932–33, the remainder of the program being devoted to considerations of the proposed International Cloud Atlas, atmospheric turbidity, measurements of color of the sea and the sky, and cyclical variations in precipitation, runoff, and lake-levels, and their relation to long-range forecasting.

The papers presented before the Section of Terrestrial Magnetism and Electricity included progress reports on the year's investigations and projects in the United States, a report on the proceedings of the International Section of Terrestrial Magnetism and Electricity at the Stockholm assembly, four papers bearing on extra-terrestrial considerations in the fields of the section, and four papers bearing on polar research. A significant feature of the first group was the indication of the large number of governmental, college, and commercial organizations in the United States and Canada which submitted progress reports, namely, twenty-one. The desirability of further magnetic and electric work in the polar regions of the earth and especially during the proposed International Polar Year of 1932–33 was indicated in the papers of the last group.

As in the other meetings, that of the Section of Oceanography was devoted almost wholly to progress reports of nine governmental bureaus and private research organizations engaged in oceanographic work, showing the wide-spread interest and rapidly increasing development. Besides these reports there were two papers telling of progress in Gulf Stream temperature-investigations and of the results obtained by duplicate measures of specific gravity of sea-water by the Knudsen and Plummet methods.

Following a paper on the solubility of water in granite magmas, reports were presented to the Section of Volcanology on Merapi and its eruptions, volcanoes of Katmai district in 1930, the Tertiary volcano at Cripple Creek, Colorado, and the Valles Mountain volcanic center of New Mexico.

The first annual meeting of the Section of Hydrology, organized in November, 1930, was very successful and well attended. Following a brief account by the chairman on the organization, activities, and plans of the section, twelve papers were presented upon various scientific aspects of hydrology. Robert E. Horton's paper on "The Field, Scope and Status of the Science of Hydrology" developed excellently the scientific possibilities of the section's field. Other papers of the program emphasized the absorption of precipitation and its penetration, glacier-measurements, organization and work of various governmental hydraulic stations and laboratories, the need for closer cooperation among students of stream work, studies in evaporation, relation of ground-water hydrology and Pleistocene geology of the Platte River Valley and adjacent areas, significant studies in hydrology on the Pacific coast, and reports on investigations in progress in hydrologic laboratories.

The report of the general secretary at the general assembly of the union showed a total membership of

222 and gave some account of the relations of the union with the international body. At the fourth general assembly of the International Union of Geodesy and Geophysics held at Stockholm, Sweden, from August 14 to 23, 1930, there were present some 302 delegates and guests representing thirty-six countries. The United States was represented by a total delegation of 27, including 14 delegates of the union. The report showed that the interest in geophysics and geophysical applications has continued its rapid growth in the United States and that the activities of the American Geophysical Union have made substantial contribution in forwarding this growth. The general secretary also reported briefly on the progress of the plans for the Jubilee International Polar Year, on the Wilkins-Ellsworth Trans-Arctic Submarine Expedition, and on the cable advice recently received from the general secretary of Aeroarctic that the *Graf Zeppelin* was to make a polar flight leaving Germany July 20 for the purpose of testing equipment assembled for scientific observations in the Arctic, as a trial preliminary to the exploratory flights from Friedrichshafen to Fairbanks and return planned for 1933.

The following five resolutions were unanimously approved:

(1) *Resolution on gravity at sea* proposed by the sections of Geodesy and Volcanology—

WHEREAS, The United States Navy Department, in cooperation with the Carnegie Institution of Washington, conducted a gravity-campaign in 1928, during which observations were made under the direction of Dr. F. A. Vening-Meinesz, Member of the Dutch Geodetic Commission, at many points in the Caribbean Sea, the Gulf of Mexico, and the Atlantic Ocean to the northward of Porto Rico, thus adding materially to the knowledge of the crust of the Earth in the regions covered, and furnishing data for the figure of the Earth, and

WHEREAS, Much additional information about gravity at sea should be obtained, therefore be it

Resolved, That the American Geophysical Union of the National Research Council recommends to the Navy Department that it give thought to the question of continuing its work on gravity at sea and of securing the necessary soundings to supplement such work, especially in the waters of the West Indies including the Caribbean Sea, and be it further

Resolved, That a copy of this resolution be forwarded to the Secretary of the United States Navy.

(2) *Resolution on international cooperation in the study of tidal waves* proposed by the sections of Seismology and Oceanography—

WHEREAS, A communication has been received through the Department of State and the National Research Council from M. Hubert, Secretary of the Commission of the International Union of Geodesy and Geophysics for the Study of Tidal Waves, suggesting and inviting participation of the United States in studying tidal waves and various phenomena associated with them, therefore be it

Resolved, That the American Geophysical Union indorses the plan of the Commission and recommends the participation by organizations and individuals of the United States who may be concerned, and in order that a suitable plan for such participation may be developed, the chairmen of the sections of Seismology and Oceanography are authorized to appoint two members from each Section as a joint committee, and be it further

Resolved, That a copy of this resolution be sent to the Secretary of the Commission of the International Union of Geodesy and Geophysics for the Study of Tidal Waves.

(3) *Resolution on comparisons of new types of seismological instruments developed in the United States with various types developed in Europe* proposed by the Section of Seismology—

WHEREAS, The Director of the Central Seismological Bureau of Strasbourg, France, has indicated the great desirability of direct comparisons of new types of seismological instruments developed in the United States with various types developed in Europe, and has offered the facilities of the Central Bureau for this purpose, preferably with the cooperation of an American seismologist, therefore be it

Resolved, That the American Geophysical Union indorses this plan, and be it further

Resolved, That a copy of this resolution be sent to the Director of the Central Seismological Bureau of Strasbourg.

(4) *Resolution commemorating fiftieth anniversary of General Greely's participation in the first International Polar Year* proposed by the Section of Meteorology—

WHEREAS, The American Geophysical Union is lending its influence toward the successful completion of the work of the Jubilee International Polar Year, 1932–33, and

WHEREAS, All the world recognizes in Major-General Adolphus W. Greely, U. S. A., retired, the leader of the Lady Franklin Bay Expedition, 1882–83, of the First International Polar Year, the outstanding figure in Arctic exploration on this continent, therefore be it

Resolved, That the American Geophysical Union record its high appreciation of General Greely's abundant contributions to our knowledge and its earnest wishes for the long continuance of his good health, and be it further

Resolved, That a copy of this resolution be sent to General Greely.

(5) *Resolution on the death of Franklin G. Tingley* proposed by the Section of Meteorology—

WHEREAS, The members of the American Geophysics Union have learned with profound regret of the death of

Franklin G. Tingley, late Chief of the Marine Division of the United States Weather Bureau, therefore be it

Resolved, That the American Geophysical Union record its profound regrets over this loss not only to its own personnel but also to the world of science in general, and especially to oceanography and meteorology, and be it further

Resolved, That a copy of this resolution be sent to Mr. Tingley's family.

The joint committee entrusted with the work involved in the resolution on international cooperation in the study of tidal waves consists of H. F. Reid, *Chairman*, Perry Byerly, N. H. Heck, and H. A. Marmer.

J. A. Fleming was reelected general secretary of the union to June 30, 1934.

The scientific session following the business session was devoted to a symposium on time-signals sponsored by the sections of Geodesy and Seismology. This symposium included the following papers and discussion:

(a) United States Naval Observatory time-service, by J. F. Hellweg; the Chairman expressed the thanks of the meeting to Captain Hellweg for his paper and his expressed desire to do everything possible in meeting the needs for more frequent time-signals.

(b) Time-signals for electrical and physical measurements, by Frank Wenner; discussed by Messrs. Bowie and Heyl.

(c) Time-signal needs for geodetic work, by Edwin J. Brown; discussed by Messrs. Bowie, Hubbert, Hellweg, and Brown.

(d) H. E. McComb, Secretary of the Section of Seismology, then read short communications from Messrs. James B. Macelwane (expressing regret that because of illness he could not prepare the paper "Time-signal needs of the seismologist"), H. O. Wood (two), and B. Gutenberg, all emphasizing the need of broadcasting time-signals at more frequent intervals and the necessity of carefully controlling wave-lengths to prevent variation from day to day; Messrs. Heck and Hellweg made detailed comments on these communications which were further discussed by Messrs. Brown, Sollenberger, and Reid.

(e) Establishment of world-time, by F. W. Lee (read by Frank Wenner); discussed by William Bowie.

(f) The service available from the standard-frequency transmitters of the Bureau of Standards, by J. H. Dellinger.

(g) The accuracy of the primary-frequency standard of the Bureau of Standards, by C. G. McIlwraith.

(h) Informal communications—Upon invitation of the Chairman, informal communications with particular reference to the papers presented in the symposium were given by Messrs. C. W. Horn of the National Broadcasting Company and H. A. Affel and Warren A. Marrison of the American Telephone and Telegraph Company and Bell Telephone Laboratories.

The marked success of the meetings of the sections and of the union hinged largely upon the excellence of the program developed and the arrangements made by the Committee on Meetings, consisting of Messrs. Frank Wenner, *Chairman*, H. A. Marmer and F. W. Sohon.

JNO. A. FLEMING,
General Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE AUTOMATIC PRESSURE REGULATOR FOR FILTRATION

IN biology especially definitely controlled pressures on filters are very desirable in as much as the nature of the filtrate is determined not only by the kind of filter used but also by the pressure on the filter. In many instances biologists have neglected to state the pressure at which the filter was operated. The pressure may be regulated to some extent by the pump itself or by a hand-operated air leak. By neither of these means is a pressure obtained which is constant for any length of time. To improve the situation a simple pressure regulator has been devised by means of which a filter may be operated at any pressure for any length of time.

The whole apparatus is so simple that it can be made by any one whose ability at glass blowing does not much exceed the making of a T-tube. Fig. 1 shows a drawing of the apparatus. A 10 cc or 20 cc syringe (a partially broken one may be used) is cut off at one or both ends. The plunger is also cut off. The longer the plunger is, however, the less oil will leak past it at high pressure. A glass tube *b* is fitted with a side arm and a guide as shown in Fig. 1. The guide is just a piece of heavy walled glass tubing cemented in place in tube *b*. Paraffin makes a satisfactory cement. Tube *b* is also provided with a slight flare at the top. Tube *a* may be either a solid or a hollow glass rod, preferably of such diameter that it fits snugly into the guide, but moves freely. If the rod is hollow, holes may be drilled above and below the guide to insure rapid equalization of the pressure throughout the system. If tube *a* fits loosely in the guide, no such holes are necessary. If tube *a* is solid, a groove may be cut along one side. The tube *a* is enlarged as shown in the illustration, and it is ground into tube *b* as a stopper is ground into a bottle. Over the ground end of tube *a* is fitted a piece of thin, soft rubber tubing. A very effective air valve is thus formed. To keep the valve closed a spring is placed

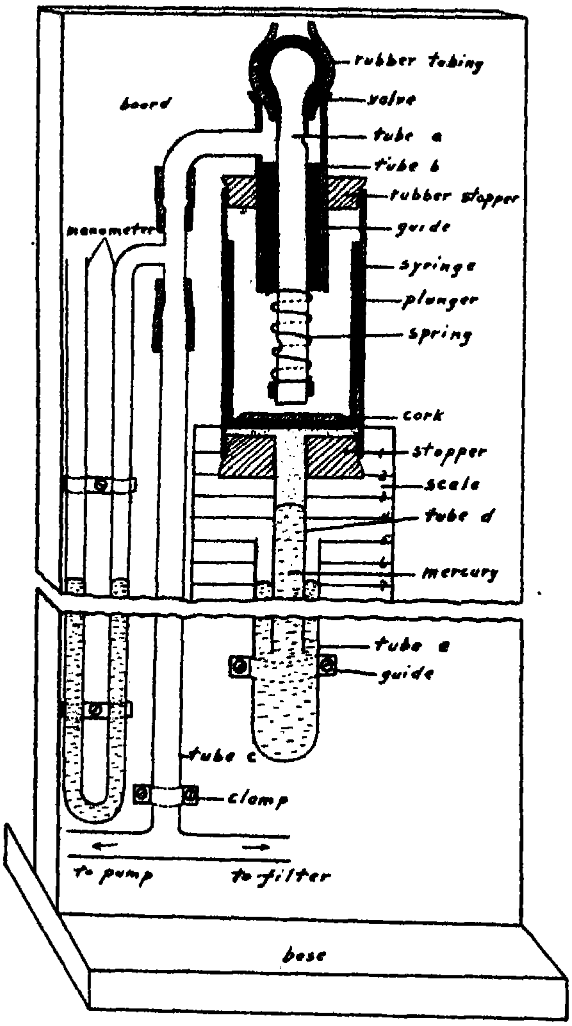


FIG. 1

over the lower end of tube *a* and held in place by a piece of rubber tubing, or any other convenient means. Into the lower end of the syringe is fitted a stopper with a glass tube *d*. This stopper should preferably be of some other material than rubber for the reason that oil will gradually cause the disintegration of rubber. A tight fitting cork stopper will do. Tube *d* should be 40 to 50 cm long depending upon the maximum filter pressure desired. An outer tube *e* is placed over tube *d*. Tube *e* should be about the same length as tube *d*. Tube *c* has on the end a T-tube one arm of which connects with the pump and the other arm with the filter. The apparatus is most conveniently mounted on a board about 10 cm wide and 80 cm to 100 cm tall. This board may be fitted with a base or screwed to a tall ring stand. The syringe and attachments may be clamped firmly to the board but tube *e* must be movable. It is best to place tube *e* in a guide, and also a clamp to hold it in the desired position. An open mercury manometer should also be connected with the apparatus. This may be conveniently done as shown in the illustration.

When the apparatus is all made tube *e* is partially filled with mercury and a few cubic centimeters of oil is poured on top of the mercury which has risen in tube *d*. The quantity of oil should be sufficient to keep the level of the mercury in tube *d* always visible and below the stopper in the syringe. Tube *d* is now lowered into tube *e* until the oil is visible above the stopper. The syringe, with the plunger protruding slightly from the lower end, can now be fitted over the stopper on tube *d* so that little if any air is trapped inside the syringe between the plunger and the stopper. The top part may now be put in place and the apparatus is ready for use.

The principle upon which the regulator works is similar to that of a hydraulic press. As the pressure falls in the syringe the plunger is forced upwards and tube *a* is forced downwards. The forces on these two are proportional to the cross sectional areas of the plunger and of the valve. If the cross sectional area of the plunger is twice that of the valve the upward force on the plunger will be twice the downward force on tube *a*. If the mercury level in tube *d* is above that in tube *e* there will be a downward pull on the plunger proportional to this difference of levels. At equilibrium the downward force on tube *a* by the outer air and the spring is equal and opposite to the upward force on the plunger by the outer air minus the weight of the column of mercury between the levels in tubes *d* and *e*. When the upward force on the plunger becomes greater than the downward force on tube *a*, tube *a* is forced up and the valve is opened. Equilibrium is thus maintained by the opening and closing of the valve. It is obvious that the greater the difference in mercury levels in tubes *d* and *e* the lower the pressure in the syringe must be to attain equilibrium. It may also be seen that the difference in mercury levels in tubes *d* and *e* is a linear function of the pressure in the syringe. By moving tube *e* up or down the equilibrium pressure in the syringe may be made equal to any desired pressure. Behind tube *e* may be placed a scale which measures the difference of the mercury levels in tubes *d* and *e* but which is graduated to read the pressure in the syringe directly in centimeters of mercury. To make the scale the apparatus is first connected to an open mercury manometer as shown in Fig. 1. Place tube *d* at a certain level. When equilibrium is attained read the manometer and also the difference of the mercury levels in tubes *d* and *e*. Repeat by moving tube *e* to different levels. Plot the results. The points should fall on a straight line. If the points are not on a straight line there is some leak or the pump is incapable of producing the desired pressure. One such curve is shown in Fig. 2. The point at

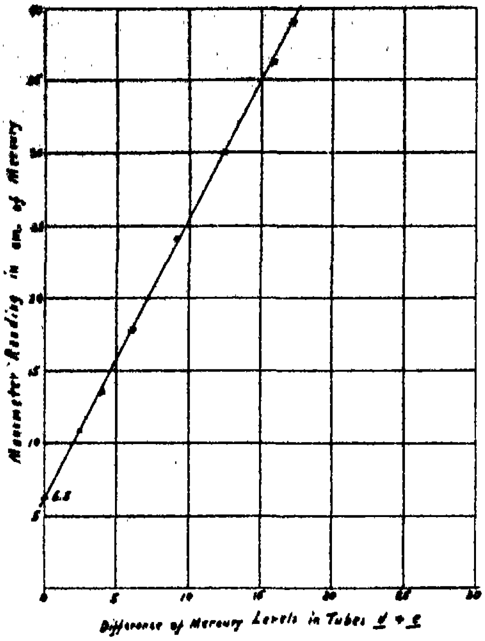


FIG. 2

which the curve crosses the ordinate represents the pressure to operate the spring. The stiffer the spring the greater this pressure will be and *vice versa*. The slope of the curve is equal to the ratio of the difference in levels of the mercury in the open manometer and in tubes *d* and *e*. In Fig. 2 it may be seen that if the difference of the mercury levels in tubes *d* and *e* is changed .55 cm that in the manometer is changed 1 cm. Therefore, if a scale is constructed with divisions equal to the slope of the curve (in this case .55 cm) but marked 1, 2, 3, etc. cm the scale will read the pressure in the system directly in centimeters of mercury. The scale is fastened behind tube *e* so that the level of the mercury in tube *d* (at equilibrium pressure in the syringe) is opposite to the pressure reading equal to that at which the curve crosses the ordinate axis, in this case 6.5 cm.

EINAR LEIFSON
THE JOHNS HOPKINS UNIVERSITY

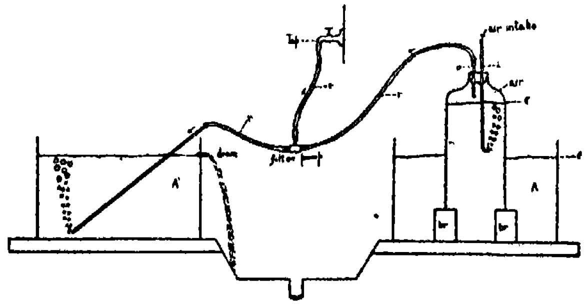
INEXPENSIVE AERATED AQUARIA

For several years the writer has been using an economical method of aerating aquaria suitable for high schools and institutions which can not afford the more expensive pressure systems used in the larger research laboratories.

The system of two aquaria (A and A′), as set up in the text figure, can be aerated efficiently at a low cost. The apparatus includes two aquaria, one bell jar (open top high form), one suction filter-pump, three pieces of glass tubing, three sections of rubber hose, one two-hole rubber stopper, and two half bricks.

It is necessary in aquarium A to place the bell jar on two pieces of brick in order to facilitate circulation of water currents. The glass tube (i) can be adjusted so that air will bubble continuously into the jar. In starting the apparatus it is necessary to have the lower end of tube (i) below the water surface (1). When the water level (1′) within the jar almost reaches the lower end of the tube (o), the tube (i) should be raised above the water level (1). The suction from the outlet (o) creates a partial vacuum in the top of the jar. This causes the water in the bell jar to approximate a level which will tend to equalize the atmospheric pressure on the water inside and outside the jar. When these two pressures are equalized the water in the jar maintains a constant level and air will bubble intermittently in the water. This causes aeration and circulation of water sufficient for the whole aquarium.

The second aquarium A′ can be used in cities where the water is not acid nor chlorinated, since the water passing into aquarium A′ is tap water. This second system was devised and used by one of the Hertwig brothers in his German laboratory.



An aquarium of type A into which there were placed fifty-five bullfrog tadpoles, seventy-six crayfish and eight small minnows operated for six weeks with only one change of water and with a loss of only three crayfish and five tadpoles. Either fresh or salt water can be used in Aquarium A.

J. HENRY WALKER, JR.
UNIVERSITY OF ALABAMA

DIFFERENTIAL FILTRATION AS A MEANS OF ISOLATING BACTERIUM GRANULOSIS

It is often difficult to separate very small slowly growing from larger more rapidly growing bacteria. This is especially true in the attempts to obtain *Bacterium granulosis* in a pure growth from cultures of conjunctival suspensions.

Bacterium granulosis usually requires four or five days for a growth sufficient for ordinary transfer. By this time, contaminating organisms such as staphylococci and diphtheroids have been multiplying rapidly, making it difficult, and frequently impossible,

to recover *Bacterium granulosis* in pure culture by the usual methods of diluting and plating.

In order to overcome this difficulty we have attempted to separate the smaller from the larger organisms by means of differential filtration.

Berkefeld "V" filters, new or used, are selected and tested for permeability for *B. prodigiosus* and staphylococci. The filters which allow the passage of *B. prodigiosus* but not of staphylococci are chosen. A suspension of the contaminated material is diluted in normal saline solution and passed through the filter. The filtrate is either spread on plates or inoculated into leptospira medium. Occasionally other small bacteria may be found in the cultures of the filtrate along with *Bacterium granulosis*. These other organisms have not offered the same technical difficulty of separation from *Bacterium granulosis* as have staphylococci, diphtheroids and other large bacteria which rapidly overgrow and suppress it.

This method, therefore, has been satisfactory in separating *Bacterium granulosis* from contaminated cultures in which it has been difficult or impossible to recover the organism in the usual manner.

RALPH E. KNUTTI
PETER K. OLITSKY
JOSEPH R. TYLER

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

SPECIAL ARTICLES

A RATION FOR THE PRODUCTION OF RICKETS IN CHICKS

UP to the present time we have used a ration consisting of 97 parts of ground yellow corn, 2 parts of calcium carbonate, 1 part of common salt, and skimmed milk *ad libitum* for the production of rickets in growing chicks. The ration is extremely low in vitamin D, and when day-old chicks are placed on the ration severe rickets is produced in 5 to 6 weeks. The ash content of the extracted tibia removed from these chicks is about 30 to 33 per cent., while the ash content of similarly treated tibia from normal White Leghorn chicks of the same age is about 40 to 45 per cent. or often somewhat higher. The addition of various sources of vitamin D to this ration, together with a study of the ash content of the bone, furnishes an excellent method for the determination of the vitamin D potency of these materials. However in the evaluation of sources of vitamin D, especially cod liver oils and other fish oils, for the poultry industry as well as for the scientific study of rickets in chicks, there has been a demand for a suitable dry ration. State inspection laboratories, looking forward to the control of marketable sources of vitamin D, find it inconvenient to use a ration containing liquid skimmed milk because of the difficulty of procuring skimmed milk daily. Another objection to the liquid skimmed milk ration is the variable intake that follows its use. Consequently we have, during the past two years, attempted to develop a suitable dry ration for the study of rickets in chicks. Dry rations have been used in several commercial laboratories and in institutions studying the problem of rickets in chicks; but it would seem advisable if the ration here proposed or some other equally suitable ration could be more generally adopted.

A ration to be satisfactory must be palatable, give good growth and in the presence of vitamin D contain sufficient calcium and phosphorus in the proper ratio for optimum calcification of the skeleton. We believe, too, that the ration should be one that gives pronounced rickets in 4 to 5 weeks—in fact, may lead to a high mortality at that age. The chick itself is particularly suitable for studies of bone development because of its wonderful sensitiveness to the absence of vitamin D. One does not need a one-sided ration, that is, high calcium and low phosphorus, or high phosphorus and low calcium, to produce rickets in the chick as has been commonly used in the production of rickets in the rat. In the case of the chick severe rickets is readily produced where the calcium and phosphorus content of the ration is at a reasonable level, and with an optimum ratio, such as 2 parts of calcium to 1 part of phosphorus.

It is true with the chick, as with other animals, that the mineralization of the bones can be influenced by the level and ratio of calcium and phosphorus in the ration. With the use of what is known as the Wisconsin baby chick ration, in which the calcium and phosphorus are particularly high, that is, approximately 2.5 per cent. of calcium and .7 per cent. of phosphorus, rickets is delayed in the absence of vitamin D and fair mineralization of the bones results during the early growing period. On the other hand, in the ration that we are suggesting for a standard rachitic ration with chicks, the calcium and phosphorus are sufficiently high to give excellent calcification where vitamin D is adequately supplied, but a very distinct picture of rickets in the absence of vitamin D. The ration that we have finally adopted is one consisting of:

59 parts of ground yellow corn
25 parts of wheat middlings (standard)
12 parts of crude casein
1 part of common salt

1 part of precipitated calcium carbonate
1 part of precipitated calcium phosphate
1 part dried yeast[1]

This ration contains from 19 to 20 per cent. of protein, .9 to 1 per cent. of calcium, and .5 to .6 per cent. of phosphorus. It is composed of materials that are readily obtainable for any laboratory and of standard materials available on the market. The yeast was added because of the better growth that was obtained through its use. White Leghorn chicks started on this ration in the presence of an adequate supply of vitamin D will weigh 300 to 325 grams at the end of 6 weeks; without the yeast they will be 50 to 100 grams lighter. We preferred to have a ration that gave good rates of growth. Day-old White Leghorn chicks placed upon this ration will become distinctly rachitic in from 28 to 35 days, and some of the birds may be dead by the end of the fifth week, with an ash content of the extracted tibia approximating 30 per cent. In the presence of an adequate supply of vitamin D, White Leghorn chicks fed this experimental ration for 35 days will weigh about 225 grams, and the ash content of the extracted tibia will generally be 43 + per cent.

Our technique in conducting the experiment is as follows: White Leghorn chicks, one-day old and weighing 30 to 35 grams, are placed in groups of 6 or 8 in warmed hovers provided with screen bottoms. These screen bottoms are made of wire mesh, either two or three mesh to the inch, and used for the purpose of minimizing excreta consumption. Shavings are placed under this false screen bottom. The birds are fed water only for the first day; but on the second day they are given small portions of the ration upon a cardboard mat. On the third day the ration is placed in suitable feeders and so continued during the 5 weeks of the experiment. If consumption records are desired the birds can be placed in individual cages and fed through suitable grids, whereby accurate consumption records can be obtained. The birds are weighed weekly. At the end of the fifth week they are killed, the tibiae removed and placed in 95 per cent. alcohol until convenient to proceed with the analysis. They are then crushed, individually wrapped in filter-paper, and extracted for 72 hours with hot 95 per cent. alcohol. Finally the bones are dried, weighed, and ashed in an electric muffle furnace for 1 hour at a cherry red heat (about 650° C.). The percentage of ash is used as the index for estimating the degree of calcification.

The curative type of experiment and the "line test" as used in the case of the rat are not possible in the case of the chick. In the healing of rickets in the chick there is no distinct line of calcification, but healing is diaphyseal and immediately contiguous with the trabeculae that remain after rickets is produced. Consequently no distinctive "line" is formed during healing.

[1] The yeast was obtained from the Northwestern Yeast Company, Chicago, Illinois. Experimental yeast (powdered yeast foam tablets) with 50 per cent. + of protein).

E. B. HART
O. L. KLINE
J. A. KEENAN

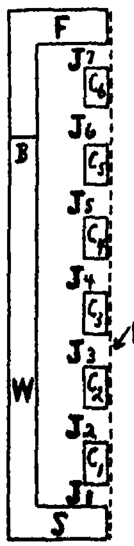
DEPARTMENT OF AGRICULTURAL CHEMISTRY,
UNIVERSITY OF WISCONSIN

AN INVESTIGATION OF "INSIGHT" IN RATS

IN some preliminary experiments conducted recently the writer sought to get further evidence on the existence of "insight" in rats.

The problem was formulated as follows: If rats have learned to take a difficult path to food in preference to an easy but blocked path, and if then the easy path is offered as a short cut to food, what type of reactions will occur? According to a mechanistic theory of learning the rats should continue to take the difficult path even if the easy path has been so arranged as to lead to food under the most favorable conditions. On the other hand according to theories which oppose the simple mechanistic formulations, one might expect the operation of "insight" as indicated by an immediate or rapid switch to the easier path.

The experimental setting designed to meet the conditions of the problem was as follows: An elevated, open maze was used.[1] (See Fig. 1.) The easy path W was an open running path blocked at B near the



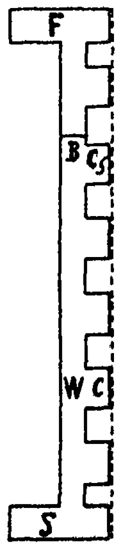


FIG. 1 FIG. 2

[1] W. R. Miles, "The Narrow Path Elevated Maze," *Proc. Soc. Exp. Biol. and Med.*, 24: 454–456, 1927.

food box F. This was separated in the initial learning from the true but difficult path C which consisted of a series of jumps from one platform to another. After the rats had learned to take the C pathway to food, the running path W was moved over until it touched the series of C platforms. In this test situation (See Fig. 2) rats therefore had the opportunity to run along W to the block and so on to the fifth platform of C, thus eliminating most of the difficult jumps along the C pathway.

If rats in such a test situation as described above should continue to take the difficult jumping path to food, their behavior could be explained by mechanistic theories of learning. If, however, they should suddenly and immediately choose the easy, running pathway, their behavior could not be so explained. Such behavior would support the striking evidence of Tolman and Honsik[2] that rats are able suddenly to go against previous habit and preference. In the present experiment all rats continued to jump in the test situation and the results therefore tend to agree with a mechanistic explanation of learning.

However, before presenting the results in greater detail, the dimensions of the maze, length of jumps and amount of preliminary training are necessary factors to be considered. Path W was 6 in. wide, 15 ft. long and was blocked at B 11 ft. 6 in. from S, the starting platform. The platforms C_1, C_2, etc., of the C pathway, were 20 in. long, 6 in. wide, and were tipped with rubber on the landing end and screen wire on the jumping end, the latter tips enabling rats to get a good foothold for the jump. The platforms and jumps along C were bordered by a wall, indicated in the figures by the dotted line P. Paths W and C were separated 12 in. during a preliminary training period.

The length of the jumps J_1, J_2, etc., was increased during the training period of 70 trials until on the 70th trial jumps 1, 5 and 6 equalled 10 in., jumps 2 and 4 equalled 16 in. and jump 7 equalled 4 in. Observations of behavior at the jumps indicated that they were made with reluctance. In the last 10 trials of the training all rats took the C pathway in preference to W. They were then tested on the 71st trial.

Results summarized briefly are as follows: Rats (N equals 7) continued to jump in the test situation for from 10 to 20 trials after the paths were moved together. The elimination of the jumps was gradual. Even after full runs along W to B had once been made, all rats persisted in many of the succeeding trials in jumping part or all of the way to platform C_5. This was done despite the fact that complete runs along the short cut W to B and thence to food by C_5 and C_6 averaged 10 seconds, while the average time along the C path was 30 seconds. A final preference for the short cut W was established and thereafter rats never took the C path, except beyond B. There was no indication that any rats "saw" into the short cut W in the test situation.

The experiment is being continued. The writer is planning to use the method as a means of analysis of habit fixation by putting path W adjacent to path C at various stages of training; by introducing in the test a new path, different from W; and by allowing path W to be a true path to food in part of the training period.

Since one interpretation of the results described above might be that running and jumping constitute separate abilities, and therefore are too different to permit a sudden change in habit, it is intended to run a comparison series in which path C consists of a running path containing a number of *cul de sacs*. At the test the two running paths will then be placed together.

Apart from the bearing of the results of this experiment on theories of learning, it would appear that the jumping activity itself should be of interest to comparative psychologists. Lashley[3] recently reported a series of discrimination experiments in which rats were required to jump, but, with the exception of the present work, the writer knows of no attempt to apply jumping to a maze situation. The contrast between running and jumping in the same rats yields sharp, objective differences in behavior and, where such sharp contrasts are needed, the activity should be valuable. It could probably be used as a substitute for some of the "obstruction" methods now in use by extending the jumps beyond the distances used here. It is likely that applications of the activity to other problems might readily be made.

H. C. GILHOUSEN

HARVARD UNIVERSITY

BOOKS RECEIVED

BIRD, CHARLES. *Effective Study Habits.* Pp. xv + 247. Century. $1.50.

BURRELL, ROBIN C. *Chemistry for Students of Agriculture and Home Economics.* Pp. xviii + 459. 75 figures. McGraw-Hill. $3.50.

CURTIS, FRANCIS D. *Second Digest of Investigations in the Teaching of Science.* Pp. xx + 424. Blakiston. $3.00.

HAMILTON, L. F. and S. G. SIMPSON, editors. *An Introductory Course of Quantitative Chemical Analysis,* by Henry P. Talbot. Seventh edition, revised. Pp. xii + 253. 8 figures. Macmillan. $2.50.

KIRKPATRICK, T. BRUCE and ALFRED F. HUETTNER. *Fundamentals of Health.* Pp. ix + 576. 100 figures. Ginn. $3.60.

NORRIS, JAMES F. *Principles of Organic Chemistry.* Third edition. Pp. xi + 595. McGraw-Hill. $3.00.

[2] E. C. Tolman and C. H. Honzik, "Insight in Rats," Univ. Calif. Publ. Psychol., 4: 215–232, 1930.

[3] K. S. Lashley, "The Mechanism of Vision," *Jour. Genet. Psychol.*, 37: 453–460, 1930.